PACIFIC SOUTHWEST FOREST AND RANGE
EXPERIMENT STATION
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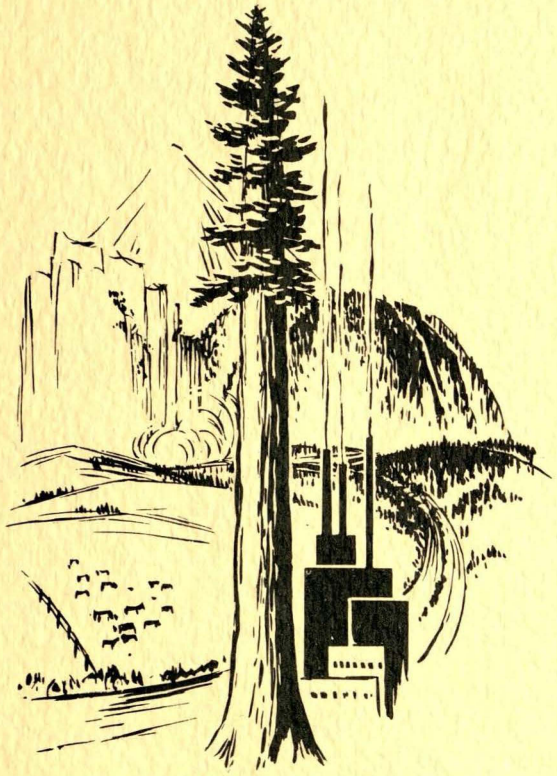
ANNUAL REPORT - 1955



U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
R. W. COWLIN, DIRECTOR
PORTLAND, OREGON
MARCH 1956

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ANNUAL REPORT OF THE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
FOR THE CALENDAR YEAR 1955

INTRODUCTION

The year 1955 has been an eventful and fruitful year for the Station. In the body of this report principal accomplishments and plans for the coming year will be described in detail. In the next few paragraphs I should like to call attention to several events and their meaning in relation to broad research needs.

The forest economy of the Pacific Northwest is becoming more predictable as it matures. Likewise, the general scope and magnitude of a supporting research program is becoming easier to define. During 1955, four events in particular brought the situation into sharper focus. Appropriately enough, two of these reviewed the past and two looked to the future.

The fiftieth anniversaries of the Forest Service and the Douglas-fir plywood industry both fell in 1955. Review of changes in the forest situation since 1905 gives us greater confidence in our ability to appraise future forest conditions and needs.

When the Forest Service was established in 1905 through transfer of the "forest reserves" from the Department of Interior to the Department of Agriculture, there was only a handful of professional foresters in the United States. Now there are some 1,800 to 2,000 foresters actively practicing their profession in the Pacific Northwest alone.

For some years before 1905, a few men of vision had seen the need for forest and related research. Here in the Pacific Northwest, during 1900 to 1902, E. T. Allen prepared and published two monographs, one each on Douglas-fir and western hemlock. Research in forest products utilization commenced in this region about 50 years ago. Need for genetics research was seen clearly 45 years ago with the establishment of a heredity and provenance study of Douglas-fir in the Pacific Northwest. Today research in all these important fields is on a greatly expanded basis, although still far from adequate.

Fifty years ago there were practically no forests under actual management in the Pacific Northwest. Only rudimentary fire protection was given to the fringes of forest bordering the inhabited parts of the region. Now practically all of the public forest land and a major part of private forest land is under reasonably intensive management.

The growth of the Douglas-fir plywood industry which developed from a bare existence in 1905 to a billion dollar industry in 1955

illustrates how rapidly the timber economy can change. This development also had a significant influence on the management and integrated utilization of our old-growth forests. It well illustrates the potentialities of research and technology.

Two forward-looking events of 1955 were the preliminary release of the Timber Resource Review findings and the publication of "Forestry and Related Research in North America." The Timber Resource Review, conducted by the Forest Service with the advice and assistance of many organizations and individuals, brings the national forest situation up to date and looks at prospective timber requirements and supply in the years 1975 and 2000. "Forestry and Related Research in North America," prepared by Frank H. Kaufert and William H. Cummings for the Society of American Foresters, appraises the current status of forestry and related research in the United States and outlines programs and goals for 1978.

What does all this mean in terms of the Pacific Northwest and the responsibilities and opportunities for forestry? A few figures will suffice to establish the importance of the region's forest resources both in the internal economy of the region and in the Nation's forest economy. Factors of importance in analyzing the region's timber supply situation are condition and extent of commercial forest land and the timber inventory, current and prospective timber growth and loss, current and prospective timber utilization, and ownership of the resource.

Commercial forest land in the Pacific Northwest totals 45.4 million acres, which is over two-fifths of the total land area in the two States. The timber industries dominate the economy of the Pacific Northwest. The region has less than one-tenth of the 484.3 million acres of commercial forest land in continental United States. In contrast it has 749 billion board feet of sawtimber, or well over a third of the 1,968 billion feet in continental United States. The region has nearly half of the Nation's softwood sawtimber.

The region has 28.7 million acres of sawtimber, 8.5 million acres of pole timber, 5.5 million acres of seedlings and saplings, and 2.7 million acres of nonstocked land. Each of these categories of forest land present numerous problems in forest management and protection. Nearly half of the commercial forest land is federally owned or managed, about 7 percent is State, county, or municipal, and the remainder is privately owned. About four-fifths of the Federal forest land and half the private forest land has sawtimber stands.

Douglas-fir is the leading species, followed by ponderosa and Jeffrey pine, western hemlock, and true firs. Half of the total sawtimber volume is in trees 31.0 inches in diameter and larger. A little more than half the total sawtimber volume is on federally owned or managed lands, somewhat less than half is on private lands, and about 4 percent is on State, county, and municipal lands.

The net annual sawtimber growth in the Pacific Northwest is 6 billion board feet and the annual mortality of sawtimber from natural causes is 4 billion board feet. Chief causes of mortality in order of importance are insect attack, disease, and fire. More subtle loss also occurs from these causative agents through degrade, reduction of yield and growth rates, and delayed regeneration. In contrast, the annual (1952) volume cut from live sawtimber in the Pacific Northwest was 14.3 billion board feet. In addition to this a considerable volume of dead and cull trees was cut and converted to useful products. A total of 231 million cubic feet of logging residues and 256 million cubic feet of plant residues were unutilized during 1952 in the Pacific Northwest.

Since this region is still converting old-growth forests which are adding little or no net increment, we can expect reasonable future increases in net growth rates. How much and how fast, of course, depends on many factors. Also we can expect a reduction in the rate of loss from natural mortality as well as increased salvage of trees dying from natural causes, Increasing use of woods and mill residues is another reasonable anticipation which is amply supported by experience of the past few years.

On the other hand, the Timber Resource Review shows that requirements for wood are increasing. It estimates an increase in the country's population to 210 million people in 1975 and 275 million in 2000. The gross national product is expected to increase from 365 billion dollars in the year 1952 to 630 billion in 1975 and 1,200 billion in 2000. Fifty years hence we may need twice as much wood as we are now growing. These all add to a challenge to American forestry with a great burden upon our research programs to supply the knowledge to meet the challenge. Kaufert and Cummings report notable progress and productive effort in the past 25 years but conclude that the Nation's research program should be more than quadrupled in the next 25 years. In no field of forest and range research was the effort found adequately supported and in some fields it was found extremely laggard.

The Society of American Foresters survey of forest research used several criteria to measure future research needs. Like the Timber Resource Review, estimates of future requirements for timber products were considered in appraising forestry needs. However, the Society study relied more heavily on comparing expenditures for forest research as a fraction of total timber products value with similar values for competitive industries. Needless to say, forest research expenditures proved to be comparatively underfinanced by this analysis. Needs for research in forestry and related subjects which could not be charged directly against timber products value were also recognized. However, no direct measure of these research needs was developed. Considering these various factors, the recommended 1978 goal of a 200 million dollar total program of forestry and related research seems modest.

This would be particularly true if the gross national products reaches 630 billion dollars in 1975, which could mean that timber products values would exceed 20 billion dollars at that time. Values of water, forage, game, and recreation produced by the forest would provide additional justification if needed for a 200 million dollar or larger program.

How, then, can we assemble and summarize all these various facts? This and preceding reports for the past 30 years or more have outlined accomplishments of this Station. Other agencies in the Pacific Northwest are continually contributing to this progress, particularly in recent years. A growing bibliography of forestry literature testifies to the efforts of many people and agencies. We know that the region's forest land is potentially highly productive. All signs point to a demand for capacity production. And we know we have much to learn before we realize that goal.

The current volume of old-growth timber and the fact that most of it is in public ownership or in private ownership dedicated to long-time management means that we will be harvesting large volumes of such timber for another 50 years. So we must continue to learn more about managing and harvesting old growth. Some of the old-growth is in timber types with which we have had little experience; they need immediate, especial attention. The upper-slope types and lodgepole pine are outstanding examples of this situation.

We have a good measure of the severity of current losses from insects, disease, and fire in forests of all ages, but we must learn more about how to protect the forest against such losses in the future. Large areas of nonstocked and understocked forests emphasize the necessity of learning more about regeneration, natural and artificial.

Problems of many kinds will inevitably arise and require solution by research. Despite growth of chemical utilization of wood we can expect a continued demand and premium for quality wood products. Although population is increasing more rapidly in the West than elsewhere in the Nation, the major markets for our timber industries will probably continue to be distant. We must aggressively study how to improve the quality of the products of our forests and our mills so we can minimize the transportation burden and market them to the best advantage. The large volume of woods and mill residues is another attractive field of research. Since timber growing is a comparatively long-time enterprise and since wood products are sold chiefly in highly competitive markets, we must have full knowledge of the economic aspects of the forestry enterprise. This, too, is a major field for redoubled research effort.

The Timber Resource Review, as its name implies, was confined to an appraisal of the timber situation. An appraisal of the forest situation must consider other uses of the forest than timber production. The bulk of the Station's program is concerned with research on production

and utilization of timber. However, a significant part of our program is directed towards watershed management and range management problems. The growing realization that water is a critical commodity and that soil is perishable is proof that we must solve the complexities of plant, soil, and water relationships. We expect increasing demand for range and wildlife use of forest ranges and for all forms of forest recreation. We must intensify our research in these fields in order to provide forest administrators with tools for enlightened multiple-use management of the forest.

I should like to direct your attention to a few specific developments during 1955 that are gratifying. One is the establishment of a Division of Watershed Management Research in the Station. Another is the expansion of our cooperative efforts in multiple-use forest management research. Execution of cooperative agreements for mutually supported research in watershed management studies on the Bull Run watershed with the City of Portland and in multiple-use management of lodgepole pine with the Pilot Rock Lumber Company are two outstanding examples of this encouraging development.

Many other instances could be cited of cooperation and assistance on the part of organizations and individuals--the counsel of our several advisory committees, for example. The educational institutions, associations, industrial concerns, private foresters, other public agencies--all are increasing contributions to research either directly or indirectly. This encourages us to plan our research programs with imagination and with confidence that we can meet future challenges.

The following chapters give the accomplishments of the Station's subject-matter divisions. The technical program of the Station is being greatly facilitated by the addition to the staff during the past year of a mathematical statistician and a technical editor.

FOREST ECONOMICS RESEARCH

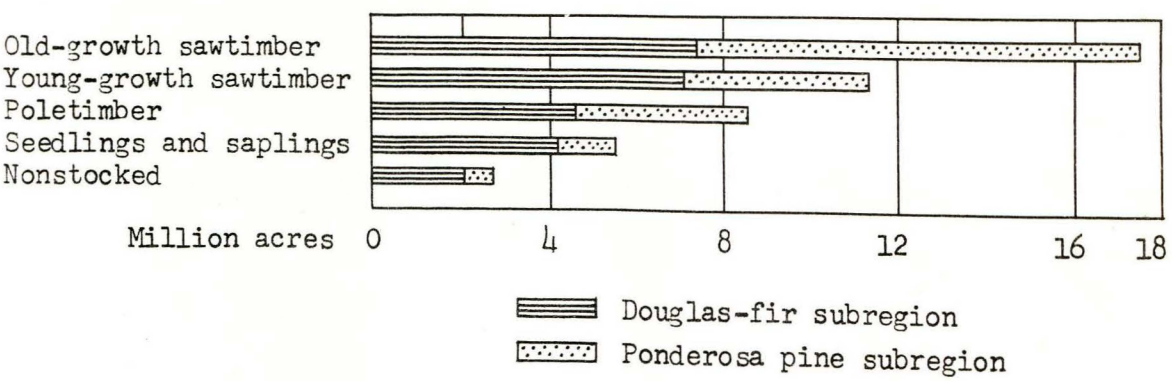
Forest Survey Statistics in National and Regional Appraisals

Release of the review draft of the Timber Resource Review late in October again emphasized the importance of up-to-date Forest Survey statistics. Forest Survey inventories, which have been conducted in the Pacific Northwest Region since the fall of 1929, first as the initial inventory and subsequently as periodic maintenance inventories, have been of great help in preparing this region's part of the fourth nationwide Forest Service appraisal made since the early 1930's.

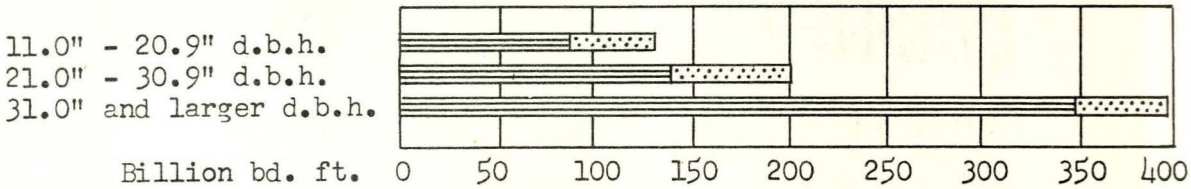
The importance of the Pacific Northwest Region's forests in the national resource picture is shown by Timber Resource Review statistics. Although the region has but 9 percent of the total area of commercial forest land in the United States, it has 38 percent of the Nation's total volume of live sawtimber. Review statistics also show that the region furnishes 30 percent of the annual volume of sawlogs consumed nationally in lumber manufacture, 43 percent of the logs used for plywood and veneer, and 37 percent of the live sawtimber cut as pulpwood.

In addition to picturing the national scene, the Review statistics are valuable in appraising the regional forestry situation. Detailed inventory data are given for the Pacific Northwest on area, volume, growth, mortality, and utilization. A few highlights are:

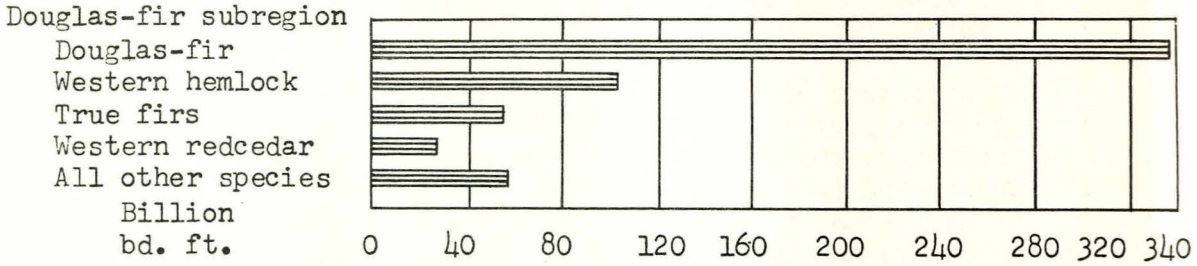
1. The area in old-growth sawtimber stands is greater than in any other stand-size class.

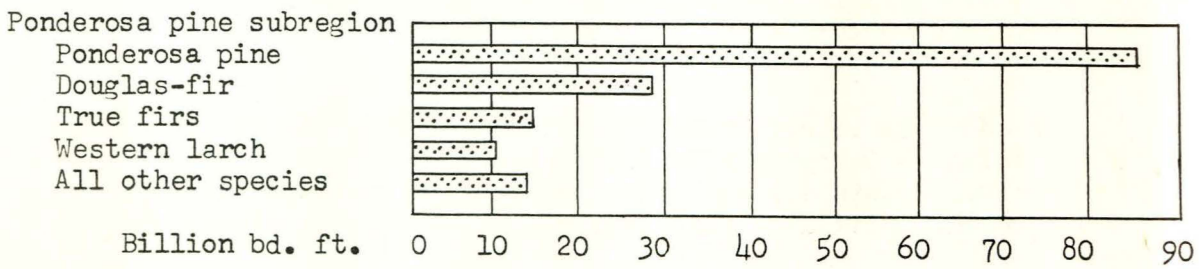


2. Half of the total volume of softwoods is in trees 31.0 inches d.b.h. or larger.

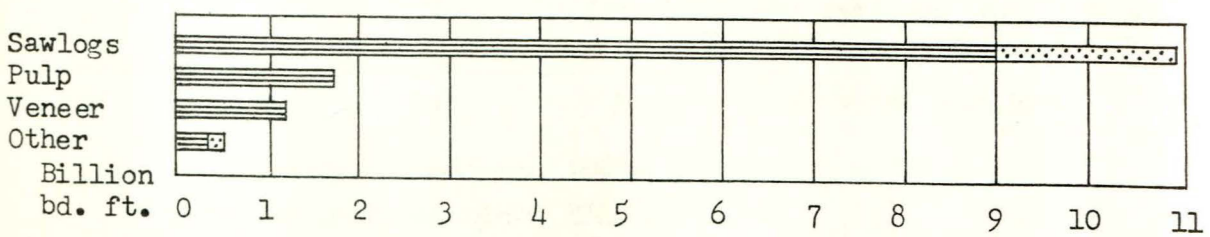


3. In each subregion a relatively few species make up the bulk of the total sawtimber volume.





4. Most logs are cut into lumber but large volumes are used by veneer and pulp plants.



Forest Survey Reinventory Progress

During the year, Forest Survey reinventory field work was completed in Snohomish County, Washington, and Lincoln and Tillamook Counties, Oregon. Work also was started in Lane County, Oregon. Total forest land area inventoried was 2.5 million acres, three-fifths of which was in Oregon and the remainder in Washington.

Following the end of World War II, survey activities were accelerated and the present reinventory cycle of Oregon and Washington was started. Through 1955, 31 million acres of forest land have been resurveyed. Annual progress of the survey during these years is shown in figure 1, with reinventories completed in 19 counties in Oregon and 20 counties in Washington.

During the year, several national forest working circles were type-mapped and intensively sampled through cooperative effort of Forest Survey and National Forest Administration. Working circles in this inventory work were the Suiattle, Sauk, and South Fork Stillaguamish of the Mt. Baker Forest, Skykomish of the Snoqualmie Forest, and the Hebo and Waldport of the Siuslaw Forest. National forest personnel contributed many man-days supplementing Forest Survey's regular sample plot program in the working circles. In addition to supplying the national forests with uniform working circle inventory data needed for management planning, the additional sample plots provided Forest Survey with more accurate information on timber volume, growth, and mortality than can ordinarily be obtained through the regular intensity of sampling.

In the office, new detailed forest type maps, on scales of 1 and 2 inches to the mile, were prepared for Columbia, Hood River, Morrow, and Wasco Counties, Oregon, and Klickitat, Thurston, and Yakima Counties, Washington. Field mapping of these counties was done in 1954. The preparation of all of these maps involved drafting a revised county base map, utilizing the most recent base data.

Office computations of forest type areas and timber volumes by ownership were completed for Columbia, Hood River, Morrow, Wasco, Klickitat, Thurston, and Yakima Counties. Also, considerable progress was made in computing timber volumes from the sample-plot data collected during the 1955 field season.

County statistical reports for Wheeler, Morrow, and Columbia Counties, in Oregon, and Yakima County, Washington, were prepared and distributed. Reinventories of the counties show considerable changes since the original inventories. For instance, analysis of Thurston County statistics shows that timber harvesting operations have materially changed the stand-size class distribution. Sawtimber area has been reduced greatly. In 1932, the initial inventory showed 84,000 acres of sawtimber, while in 1954 the area had decreased to 48,000

acres. This decrease has been accompanied by a large increase of pole-timber stands--from 59,000 acres in 1932 to 222,000 acres in 1954. It is encouraging to find that reproduction has been established on practically all areas recently cutover and previously classified as nonstocked.

Western Regions Forest Survey Techniques Meeting

The Forest Economics Division was host to a Forest Survey meeting in Portland, October 20-25. Representatives of the Washington Office, the California, Intermountain, and Pacific Northwest Stations, and the Alaska Forest Research Center, met to discuss techniques, specifications, and procedures currently in use in Forest Survey work in the Western States and Alaska. One result of the meeting was the establishment of a number of working groups to study ways and means of improving Forest Survey procedures and developing uniform standards and specifications for certain items required by Forest Survey.

Other Activities of Forest Survey in 1955

There was no reduction in 1955 in the volume of service work connected with Forest Survey. Number of requests for Survey statistics, forest type maps, and special computations and analyses of data was comparable to the average annual number during the previous 5-year period. The "requested" mailing list for county statistical reports, presenting results of recent reinventories, continues to grow and now numbers about 600. There were some 400 orders for county type maps, which was above the average for recent years.

To obtain detailed representative information on timber involved, several special analyses were made of sample plot data collected in recent county reinventories. One large forest industry company spent considerable time in analyzing sample data on diameter and log heights of various species in order to estimate probable log size from future operations. In this case, the objective was to obtain guidance for installation of equipment in new or existing plants.

A cooperative study was made of the volume of sawmill residues--particularly coarse residue suitable for pulp or fiberboard--resulting from current mill operations in three representative counties in western Oregon. The study included both total volume and volume not now being utilized. Cooperators were a local pulp company and the Oregon Forest Products Laboratory.

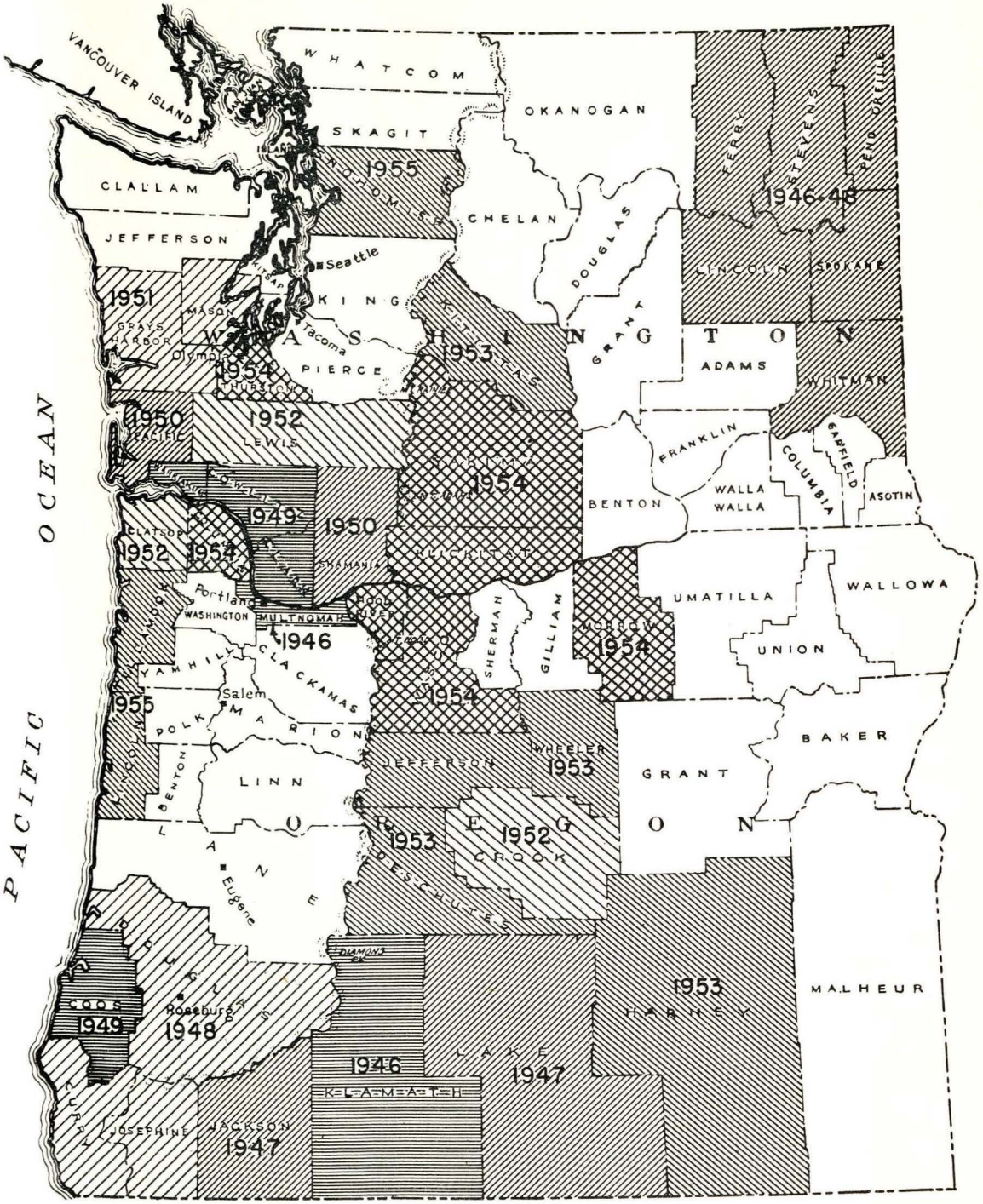


Figure 1.--A decade of progress in Forest Survey, 1946-55.

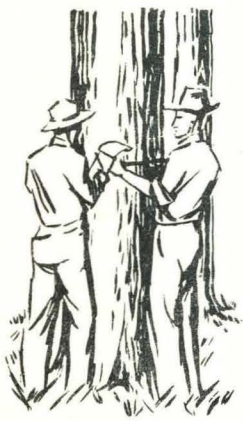
Interest was particularly great during the year in the location of concentrations of red alder, bigleaf maple, and other hardwoods in sufficient volume to constitute a stable supply of raw material. Several requests from local and eastern pulp companies, consulting foresters and engineers, and railroads, were for Survey statistics, forest type maps, and specific information on availability and character of hardwood volume. Chief interest in red alder and other hardwoods was for pulpwood, to be used in a semichemical process. There also was some interest in alder and maple sawlogs for furniture and specialty stock. Currently, three pulp plants in the region are using alder and other hardwoods. Other plants probably will use them soon.

The live sawtimber volume of hardwoods on commercial forest land in the region is estimated to total about 15 billion board feet, log scale, Scribner rule--roughly 2 percent of the total volume of all species. Many hardwood stands are of timber less than sawtimber size. Fortunately, however, pulpwood 4- and 8-foot bolts with a minimum top diameter of 5 inches are now taken by the pulp plants, which makes possible the utilization of pole-size timber. Total estimated growing-stock volume of hardwood species in trees 5 inches d.b.h. and larger is:

	Douglas-fir subregion (Million cu. ft.)	Ponderosa pine subregion (Million cu. ft.)
Red alder	3,426	
Other western hardwoods	2,144	43
Total	5,570	43

Many private and public groups are interested in up-to-date statistics on commercial forest land areas and on timber volumes by county or even smaller units. In the case of counties not recently covered by a Forest Survey reinventory, the requests are for information and methods with which to bring the earlier inventories up to date.

Forest Survey Program in 1956 Will Continue to Coordinate With Working Circle Inventories



In view of the need to develop up-to-date inventories of national forest timber, it is planned to continue in 1956 the cooperative inventorying of working circles by Forest Survey and National Forest Administration. It is very probable that the area covered during the year, through the cooperative effort, will materially exceed the coverage of previous years.

Plans call for completion of the Suiattle Working Circle on the Mt. Baker and the Waldport Working Circle on the Siuslaw. Work started in 1955 on these circles was not completed due to bad weather of an early fall. Inventory work will be initiated and completed in the Mapleton (Siuslaw), McKenzie and Oakridge (Willamette), Cottage Grove (Umpqua), and Pine and Union (Wallowa-Whitman) Working Circles. In addition, work may be done in three working circles on the Umatilla and three on the Wallowa-Whitman.

Forest Survey also plans to make a complete inventory during the year of all lands in Lane County. This county has a total forest land area of more than 2.5 million acres and was last inventoried in 1942. Since then, the timber cut has averaged 1.2 billion board feet annually. Also, much change has occurred due to restocking and growth.

Surveys will be made of several counties in the Blue Mountain area of northeastern Oregon. These will include all forest lands in Baker County and parts of Umatilla, Wallowa, and Grant Counties.

Detailed forest type maps, on scales of 1 and 2 inches, will be prepared during the year for the areas covered by field inventory in 1955. This will result in complete maps for Snohomish, Lincoln, and Tillamook Counties, and partial-county maps covering the Sauk and South Fork Stillaguamish Working Circles in Skagit County and the Skykomish Working Circle in King County. Preparation of these type maps will include compilation of base data and drafting of revised county base maps.

Office computation of forest type areas and timber volumes by ownership will be completed for the three counties and three working circles listed in the preceding paragraph.

Forest Survey publications scheduled for release during the year will include county statistical reports for Hood River, Wasco, Lincoln, and Tillamook Counties, in Oregon, and Klickitat and Snohomish Counties, Washington. A statistical-analytical report for the Douglas-fir subregion of western Oregon and western Washington is also planned for publication.

Increased interest in utilization of logging residues and the need in Forest Survey to determine the total volume of drain on the forest inventory due to harvesting of forest products, has stressed the desirability of periodic residue surveys. In the past, several surveys have been made in the region by the Forest Service and other public agencies. However, they have not been at regular intervals and none has collected all the information necessary to determine the complete drain story in terms of Forest Survey inventories.

Logging residue studies are technically difficult, time consuming, and expensive to make. An important complicating influence is the common practice throughout the region of relogging all or a portion of the residue on logged areas sometime subsequent to the initial operation. Other problems are the extreme variation in utilization among forest land ownership classes and among logging operators, and the extreme sensitivity of utilization to the current market situation.

It is proposed to conduct technique studies on logging-residue surveys in Lane County this year at time of the inventory work. The possibility will be explored of using individual tree samples, either by diameter class or by very small plots. Such studies should aid Forest Survey field men in estimating utilization of tops and cull and breakage factors.

In designing the survey procedure, consideration will be given to collecting information of value to forest industries about residue--its location, character, volume, and possible-use classification.

Some Economic Aspects of Douglas-fir Stand Establishment

The problem of establishing a new stand following cutting is not a biological one only. Even if all the silvicultural techniques were fully understood, it still would be necessary to weigh each proposed course of action on the economic scales.

Alternative methods of stand establishment usually consist of various combinations and degrees of costs and returns. Costs will depend upon jobs required, such as planting, artificial or natural seeding, brush control, rodent control, replanting, and seedling release. The returns depend mainly on site quality and yield, planned rotation, management intensity, and estimated stumpage values. By use of valuation techniques, the costs and returns of each possible method on a particular cutover area may be expressed in terms of relative present value. The method with the highest present value would represent the best choice.

A problem on some cutover areas is whether to plant immediately or wait for natural regeneration. In this case other factors, such as brush, rodents, and replanting, are not considered part of the problem. The economics of the problem is to determine what time lapse for natural stand establishment is the financial equivalent of a given planting cost. The allowable time lapse may range from 5 to 20 years on site III land or from 3 to 11 years on site II.

Additional details on the above points, plus some cost figures for various jobs associated with stand establishment, are contained in Research Paper No. 15, "Economic Considerations in Douglas-fir Stand Establishment," September 1955.

Determining Cost Ratios by Species for Stand Establishment

In southwest Oregon there is often a question as to whether Douglas-fir, ponderosa pine, or sugar pine should be favored as the new crop on a given area. Although sugar pine appears to be the most desirable, it must bear the additional costs of blister rust control.

A comparative analysis of the three species was made during 1955 to determine what amount might reasonably be spent to establish one species rather than another, on a given area. Our knowledge and ability to predict what should be or will be accomplished over a rotation is insufficient to provide meaningful financial data. Rather than theorize as to all the detailed costs and returns for each species, it was considered more realistic to recognize those items which would tend to be the same regardless of species and eliminate them from the comparison. As a result, the analysis was narrowed to harvest yield, stumpage value, initial establishment, and blister rust control.

The comparative amounts which might be spent to establish a pine crop for every dollar needed to establish a fir crop on a given area having a particular combination of site indexes can be derived from the following table:

Cost Ratios of Establishing Ponderosa or Sugar Pine Versus Douglas-fir on a Given Area Under Various Site Index Combinations--Different Stumpage Rates Assumed 1/

DF site index		SP or PP site index							
		90	100	110	120	130	140	150	160
		Ratio 2/							
110	SP	1.6	2.2	2.7	3.4	4.2	5.1	5.9	6.8
	PP	1.2	1.6	2.1	2.6	3.1	3.8	4.5	5.1
120	SP	1.2	1.6	2.1	2.6	3.1	3.8	4.4	5.1
	PP	0.9	1.2	1.5	1.9	2.4	2.8	3.3	3.8
130	SP	1.0	1.3	1.6	2.0	2.5	3.0	3.6	4.1
	PP	0.7	1.0	1.2	1.5	1.9	2.3	2.7	3.1
140	SP	0.8	1.1	1.4	1.7	2.1	2.5	3.1	3.4
	PP	0.6	0.8	1.0	1.3	1.6	1.9	2.2	2.6
150	SP	0.7	0.9	1.2	1.5	1.8	2.2	2.6	3.0
	PP	0.5	0.7	0.9	1.1	1.4	1.6	1.9	2.2
160	SP	0.6	0.8	1.1	1.3	1.6	1.9	2.3	2.6
	PP	0.5	0.6	0.8	1.0	1.2	1.5	1.7	2.0
170	SP	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.4
	PP	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.8
180	SP	0.5	0.7	0.9	1.1	1.3	1.6	1.9	2.2
	PP	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.6

1/ Douglas-fir 70 percent of ponderosa pine and ponderosa pine 75 percent of sugar pine. Based on long-term price trends.

2/ Indicates relative maximum cost for sugar or ponderosa pine where Douglas-fir cost equals 1.0.

Thus, assume an area had a DF site index 140 and PP or SP site index 120. If it cost $30 per acre to establish Douglas-fir, the expenditure for ponderosa pine could be $39 and for sugar pine, including blister rust control, $51 per acre. Of course, judgment must be used; an unreasonable cost of establishing a certain species on a site unfavorable for that species (i.e., DF on dry, southerly exposures) should not be used as a basis for spending two or three times as much for another species.

Plans for Additional Forest Economics Research Studies

Plans for 1956 include a study of Douglas-fir and western hemlock end-product selling values for use in a proposed revision of the timber appraisal base on west-side national forests. Some work also may be started in the field of timber products marketing and in developing information requested by the Corps of Engineers for its revision of the 308 Report of the Columbia River Basin. As in the past, there probably will be numerous short-term projects the nature of which cannot be foreseen at this time.

FOREST UTILIZATION SERVICE

Markets for wood products have been strong in recent years and demand for timber to supply these markets has increased stumpage and log prices noticeably. These higher raw-material costs have stressed the need for improving utilization both in the woods and in the manufacturing plants. Recent surveys reflect this in showing that less than half as much unutilized material is left after logging as was the case 10 years ago. More defective, poor-quality, and small logs are used, leaving less material on the ground to rot or burn.

The preliminary draft of the Timber Resource Review shows that during the past several years there has been a gradual decrease in the quality of logs going into primary manufacturing plants. This is caused chiefly by the following reasons: (1) Logging started in the most accessible and best quality timber and has moved gradually into areas of lesser value, and (2) as stumpage became scarcer and higher priced, a greater percentage of the volume on a timber area was logged.

Increased Use of Residues

The volume of slabs, edgings, sawdust, veneer clippings, and other residues produced per thousand board feet of logs has not changed much in recent years. It is true that greater emphasis is given to getting the maximum amount of end product out of each log entering the manufacturing plant. However, a greater number of defective logs, containing more material unsuitable for the end product, are being brought in out of the woods. Remarkable progress has been made in finding uses for residues. An outstanding example is the production of pulp chips from slabs, edgings, veneer cores, clippings, and similar material, which a few years ago had practically no commercial value.

Manufacturing residues also form the primary source of raw material for the fiberboard industry. This region has 9 hardboard and softboard plants in operation and 2 under construction. The combined annual rated capacity of these plants is over 600 million square feet. Four particle-board plants are in operation and another is under construction. All the raw material for these plants comes from mill residue and other material formerly unused. For 1955 these plants utilized the equivalent of about 147,000 cords of wood residue.

As markets developed for pulp chips, sawmill operators became aware of the need for whole-log barkers so that maximum utilization can be made of slabs and edgings. Some of the larger companies installed hydraulic barkers, which are very expensive and cannot be economically justified without large production. A few good mechanical log barkers have been developed which are not too expensive for medium-size sawmills. Last year, several of these mechanical machines were installed. This trend is expected to continue as the pulp-chip market develops. The Pacific Northwest needs more pulp mills to fully utilize available sawmill and plywood residue.

Hardwood Utilization

In the past, western hardwood timber has been given little consideration, although there are 17 billion board feet of this material in Oregon and Washington. Alder, the most plentiful species, has been used to a limited extent for furniture, paper plugs, and novelties. With improved markets, more emphasis is being given this species. Alder lumber now competes successfully with eastern hardwoods in the Los Angeles furniture trade. Work done by the Forest Service and the Oregon Forest Products Laboratory has contributed much toward establishing log and lumber grades. Tests showed that National Hardwood Lumber Association rules can be applied to western species with minor modifications. If western hardwood lumber is to be sold in direct competition with eastern hardwoods, it is desirable that the same grading rules be used.

Pulping of alder, which is a very recent development, offers an outlet for small and low-quality trees formerly unutilized. A few years ago, the U. S. Forest Products Laboratory developed the semichemical process, which is well adapted for pulping hardwoods. A few plants utilizing this process have been constructed in the eastern half of the country. And, in 1955, the first plant of this type in the West began operation. It is expected that additional western plants will be constructed, thus broadening the raw material base. Some pulp products, particularly kraft liners made from Douglas-fir, can be improved if blended with hardwood semichemical pulp.

With increased interest in western hardwoods, it appeared desirable to organize a trade association to represent this segment of the wood-using industry. Accordingly, the Northwest Hardwood Association was incorporated during the fall of 1955.

Wyssen Skyline Crane

For some time forest managers have been looking for a type of logging equipment that can be used on (1) steep, rugged topography now considered inoperable by present logging methods, (2) rocky areas where

road costs are abnormally high, and (3) areas--such as municipal watersheds--where it is important to minimize soil disturbance. Arrangements were completed for testing a machine that appears to fulfill all three of these requirements. This machine, the Wyssen Skyline Crane, was developed by a Swiss, Jacob Wyssen, for logging timber in mountainous country in his native land.

The skyline crane combines the principles of high-lead logging and aerial transportation. Full advantage of gravity is taken in moving the logs from the mountain sides to the landings in the valleys. Operations using a skyline up to 7,000 feet in length are considered economical.

The largest machine developed by Wyssen is being tested on a 7.2-million-foot experimental sale on the Okanogan National Forest in Washington. To date, over 2 million feet of logs have been removed at costs comparable to tractor logging. Costs are summarized as follows:

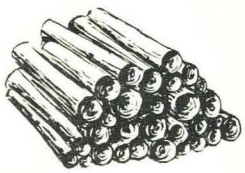
Logging	Costs per thousand	
Falling and bucking	$3.30	
Yarding and skidding, logging equipment repairs (labor), and supervision	9.00	
Logging equipment repairs (parts)	.99	
General and administrative	1.48	
Logging equipment depreciation	1.10	
Payroll taxes and insurance	1.38	
Slash disposal	.65	
Snag felling	.39	
Fire protection	.11	$18.40

The logs are sold at the landings to a lumber company in Twisp. It is estimated that construction and maintenance of roads, and loading and hauling the logs 12 miles to the mill, cost slightly over $8 per thousand.

Major advantage of this skyline system is that much less road is needed than for tractor logging. To log this 7.2 million feet of timber on the 1,000-acre tract, only 1 mile of road will be necessary. This is only 10 percent of the estimated amount needed if tractor logging was used. Yarding costs for the Wyssen system are higher than on a tractor operation but the added yarding costs are more than offset by the savings in road costs.

Two larger machines are being developed by Wyssen. When these are completed, there will be a machine suitable for logging every size of timber found in the West. This type of equipment undoubtedly will gain favor as logging moves into the more mountainous country, where road costs are higher and soil erosion problems more critical.

Deterioration of Hemlock Logs in Cold Decks



It is now customary in this region to deck large volumes of logs to sustain manufacturing plants during periods when weather does not permit logging. These logs are often stored in decks for as long as two years and they suffer considerable deterioration by season checking and decay. Some decks have been sprinkled with water continuously during the summer to avoid risk from fire. In cooperation with the Division of Forest Disease Research, a study on the deterioration of cold-decked hemlock logs was started in 1954 at the Oregon Pulp and Paper Company, Salem, Oreg., to determine whether sprinkling cold decks minimizes deterioration of the logs.

During the summer of 1955, temperature readings were taken at the surface and inside logs in both the dry and water-sprinkled decks, using an electric potentiometer to determine whether the cooling effect of water might be enough to affect the growth of decay fungi. While final results will not be available for another year, preliminary indications are that sprinkling gives no appreciable cooling effect except on the surface of logs exposed to the sun.

Lumber Grade Recovery Studies

Work on log grades for associated species of the pine type was continued in cooperation with government agencies selling timber, the Western Pine Association, and the Oregon Forest Products Laboratory. Until recent years these species were given only minor consideration and there was little need of lumber recovery data or log grades. This situation has changed. At present, approximately 40 percent of the lumber cut in the pine region comes from associated species. With increased utilization of these species, information is needed to better appraise the value of both logs and stumpage.

During 1954, two mill studies were made in Oregon and data were collected on Douglas-fir, white fir, and larch. These data were used as the basis for establishing a set of trial log grades. During 1955, another study covering these three species was made at a sawmill in Halfway, Oreg. The object of this study was to test the adequacy of the grading rules and to gather lumber recovery data from a different part of the pine region. Reports on these studies will be published by the Oregon Forest Products Laboratory.

At the request of lumber companies and the local national forest supervisor, a ponderosa pine lumber recovery study was made at Lakeview, Oreg. This study was made to determine how current lumber recoveries for that area compare with recoveries revealed in previous studies by this Station and still used for appraising pine timber. In the Lakeview study, lumber recovery data were obtained on 588 logs cut during a week's time at the American Forest Products Corporation sawmill. A record was kept at the green chain of lumber items and grades by individual logs. Lumber was then kiln dried, surfaced, and again graded. A research note has been released showing results of the study.

In conjunction with the Lakeview pine study, a 1-day run of 283 white fir logs was made. Results of this study also have been summarized and released in a research note.

Degrade Studies

In association with the lumber recovery studies at Halfway and Lakeview, Oreg., detailed information was gathered on changes in lumber quality and volume occurring during drying and planing. Data from these two degrade studies will be summarized and released in two separate reports. These reports should be of considerable value to the lumber industry as there is little factual information at present on degrade and volume loss occurring by lumber grades from seasoning and surfacing lumber.

Appraisal Base Study

During the last half of the year, a cooperative project was started with the Regional Office Division of Timber Management to determine the practicability of appraising logs in the Douglas-fir subregion on an end-product basis; at present, timber in this area is appraised on a log basis. In recent years, the truly competitive log market has progressively become less of a reality and it now appears desirable to use lumber, plywood, and other end products as the starting base. From past studies, a fair amount of data are available on lumber recovery from Douglas-fir. Many additional studies are needed to develop data on veneer recovery from peeler logs and lumber recovery from hemlock and other species.

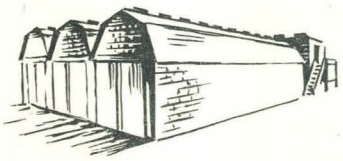
Veneer and Plywood

The Douglas-fir plywood industry celebrated its Golden Jubilee in Portland in June. During the last 50 years, this industry has shown remarkable growth. Plywood production in Oregon and Washington totaled 4.2 billion square feet of 3/8-inch plywood last year and required 1.8 billion feet of logs. Approximately 16 percent of all logs produced in the Douglas-fir subregion of Oregon and Washington are used by the plywood industry.

Competition for peeler logs is keen and the industry has been able to utilize lower grades of logs than was feasible a few years ago. Also, there is a continuous increase in use of white-pocket-infected Douglas-fir, hemlock, and other species.

A plywood plant under construction at Madras, Oreg., will be the first in this region to use east-side Douglas-fir as the raw material.

Seasoning



Interest continues in this region in kiln drying as one of the important steps in manufacturing lumber. An important method of training personnel for this purpose is through short courses of instruction such as those given by the Oregon Forest Products Laboratory each year. This division and the U. S. Forest Products Laboratory have consistently cooperated by furnishing part of the instructional staff. Applications for enrollment in the course this year were so heavy that a second course was scheduled. Total enrollment for the two courses was 60 persons, principally from Oregon but also from Idaho, Washington, California, and New Mexico.

At the U. S. Forest Products Laboratory at Madison, Wis., a project is under way to develop better schedules for kiln drying lumber of various species. One phase of this study relates to a correlation between schedules based on moisture content of wood being dried and schedules based on the length of time the lumber has been in the kiln. This Station cooperated in the field work of this project, which included a survey of commercial kiln-drying operations and schedules used in both pine and Douglas-fir areas. Data will be analyzed and results incorporated in recommendations for improved drying of lumber.

Laminating

Field observations again were made on performance of laminated structural bridge members. Douglas-fir arches glued with waterproof resorcinol resins and pressure treated with creosote continue to show no deterioration. Bleeding of the creosote has been sufficient to form a surface covering which protects the wood from weathering, moisture absorption, and shrinkage. The risk of weather checking and delamination of glue joints is minimized when the wood has such a protective coating. Another laminated arch, which was treated with waterborne solutions, is showing considerable weather checking and some opening at the glue joints due to lack of protection.

Battery Separators

A unique use for wood--thin sheets of grooved veneer for separators in electrical storage batteries--has recently been greatly curtailed.

For many years most storage batteries were constructed with wood separators, made first of Port-Orford-cedar and then of Douglas-fir. Best quality clear wood was used for this purpose. Then, exhaustion of suitable Port-Orford-cedar timber and demand for top-grade Douglas-fir by the plywood industry led to a search for other suitable material. Pulp and refined wood fiber, treated with resins, have been developed for separator use. Separators made from such material are now in production. Separators also have been made of many nonwood materials providing satisfactory and more economical performance.

In 1948, this industry used 30 million feet of highest grade Port-Orford-cedar and Douglas-fir wood for battery separators. By the end of 1955, most of this production in the region had been discontinued and there is little evidence that the large-scale use of wood battery separators will be revived.

Paint Performance

Forest Service personnel inspected performance of exterior paint on a number of Forest Service buildings and residences. Experience with paint on these structures parallels that of housing in general in that zinc-formulated paints suffer blistering and scaling in areas of much rain. Use of unpainted redcedar siding, given only a stain oil treatment, has resulted in less maintenance and this finish is increasing in use. In midwest sections of the United States zinc-free paints are being introduced--some containing only titanium and others containing both lead and titanium. Paints of this type have only recently been distributed in the West and so have not yet developed a service performance record in this region.

Plans for Forest Utilization Research in 1956

Work of the division will continue much the same as in the past. Working relations will be maintained with industry and with the U. S. Forest Products Laboratory and other institutions doing research on wood utilization. Major emphasis will be given the following:

1. The end-product timber appraisal base study.

2. Veneer and lumber-grade yield studies in the Douglas-fir subregion.

3. Lumber grade recovery studies for associated species in the ponderosa pine subregion.

4. Studies on degrade developed in kiln drying and surfacing lumber in both the Douglas-fir and ponderosa pine subregions.

5. Laminating and uses for glued laminated wood products.

6. Improving methods of drying lumber in kilns.

7. Utilization of western hardwoods for pulp, lumber, and other products.

8. Effects of growth conditions on wood quality.

9. Utilization of white pocket Douglas-fir and other low-quality wood in paper-faced veneers and similar products.

10. Improvements in methods and equipment in logging and primary manufacture.

11. Revision of manuscript "Cost of Hauling Logs by Motor Truck and Trailer."

12. Performance of exterior house paints in protecting wood.

FOREST DISEASE RESEARCH

The importance of forest diseases in the economy of Oregon and Washington is clearly shown in the Timber Resource Review. In this region, annual loss of actual and potential volume through disease is estimated at more than 1.4 billion board feet of sawtimber. This is equal to 10 percent of the region's live timber cut in 1952, and to 24 percent of current annual net growth.

Although satisfactory control of most forest diseases will be impracticable for many years to come, losses can be considerably reduced by proper management and especially by prompt and efficient salvage. Since detailed and accurate information on distribution of losses is necessary for their reduction, an adequate program of disease surveys is obviously essential to good forest management.

Nursery and Plantation Diseases

Fusarium root rot. The division is pursuing investigations of Fusarium root rot of ponderosa pine in the Forest Service tree nursery at Bend, Oreg. From year to year, control results at the nursery have varied from fair to excellent. Because of the need to prevent widespread losses, the best control treatment developed to date was tried on a nursery-wide basis.

Treatment consisted of a spring application of fresh pine sawdust, aluminum sulfate, and fertilizer, all disked into the soil before sowing. The result varied from an almost complete crop failure to fair control of the root rot losses. Analyses of the losses indicated that one outstanding need is to change the usual time of sowing to avoid producing a crop of succulent seedlings in midsummer when soil temperatures are highest and the Fusarium is most virulent.

Whether early spring sowing will produce stock able to withstand the ravages of root rot, or whether late summer sowing will produce seedlings hardy enough to withstand the rigorous Bend winters, remains to be determined. In any event, the time of sowing in the future will depend on the treatment used, rather than the reverse. Other factors of primary importance in the control program are seed source, watering, and crop rotation. Greenhouse tests are being run to supplement field applications.

Damping-off. A series of preliminary tests was made at Wind River to provide supplementary information for the regular nursery-wide treatments now being used to control damping-off of Douglas-fir seedlings. In occasional years, the regular treatment has not been effective. It will be necessary to continue small-scale tests until a severe damping-off year is again encountered and a true evaluation of the treatments can be obtained.

Storage problems. Refrigeration preserves stock in a dormant state until it is needed for planting. During the past year, Douglas-fir planting stock developed considerable root rot at several planting sites, apparently as a result of root damage during cold storage. Investigation showed, however, that more stock was being taken from cold storage than could be planted within a week's time. Consequently, the surplus stock, which was held over in heel-in beds, developed molds that normally are of little consequence when stock is planted soon after removal from cold storage.

As a result of this investigation, planting agencies were advised to take smaller and more frequent loads of seedlings to the planting sites, and nurserymen were advised to date planting stock when it enters storage so that the older stock can always be shipped first.

Mycorrhizal studies. These studies, started in 1951, are still in progress and a paper on the mycorrhizae of ponderosa pine is about ready for publication. Further studies on Douglas-fir mycorrhizae are needed to determine their significance in survival of planted stock.

Foliage Diseases

Needle blight of ponderosa pine. During a roadside survey, covering 895 miles of pine type in Oregon and 219 miles in Washington, no previously unobserved areas of heavy infection were found. Although about four-fifths of the survey in Oregon was made in localities where the blight was known to be common, only 5 percent of the stands examined had a fifth or more of their pine foliage infected. Less than 1 percent of the stands had a third or more of their pine foliage infected.

These figures would have been slightly higher except that much of the affected timber has been salvaged from the oldest and worst infection centers. The survey clearly indicates that serious damage by the disease is occurring on only a very small part of the total pine acreage.

Damage studies were extended to include pole stands, primarily to determine the extent to which expenditures for stand improvement can be justified in blight areas. Work was started to determine reasons for the

marked localization of this disease. Forty pine foresters were taken on a show-me trip to two stands where progress of the blight has been recorded for several years. The effects of the disease were demonstrated on plot trees of known history, and cutting practices for reduction of damage were suggested.

Stem Diseases and Decays

Ponderosa pine dwarfmistletoe: killing by sprays. By using various strength sprays it has been determined that many of the 2,4-D and 2-, 4-, 5-T derivatives are too harmful for general application. However, a few sprays appeared not to damage the ponderosa pines seriously and proved quite effective against the aerial part of the dwarfmistletoe plant. Research is needed to determine means of getting dilute solutions into the sapstream so that there will be a greater probability of destroying the mistletoe haustoria.

White pine blister rust. Several thousand sugar pine seedlings in nursery beds were artificially inoculated with blister rust. It is known that occasional sugar pines are resistant to the rust, and these inoculations are expected to make possible the early recognition of such resistant individuals. They will be used to breed planting stock that will not take the disease, even where ribes are not eradicated.

Decay of beetle-killed timber. Studies of rates of deterioration of beetle-killed Douglas-fir and Pacific silver fir are progressing as rapidly as suitable trees become available. Estimates of decay cull in Pacific silver fir were compared with actual pulp yields and with standards of the Puget Sound Scaling Bureau. A joint manuscript by members of the station and industry has been submitted for publication in the Journal of Forestry. Also a popularized trade journal article, summarizing the work, is in preparation. Additional studies will be made during the 1956 field season on other practical phases of the study.

Results of another, small-scale study indicate that blight-killed ponderosa pines do not deteriorate quite as rapidly as beetle-killed trees, although the difference is only slight. Additional data are needed to determine if the difference is significant.

Heart rot in pruned Douglas-fir. Field work on this study was completed, and results will be published in 1956. Preliminary computations indicate that pruning does not materially increase heart-rot hazard, provided that the pruning is done with reasonable care and does not include more than about a quarter of the living crown. In several infected young trees, pruned more than 20 years ago, the

heart-rotting fungi apparently became inactive soon after the wounds healed, and recent cultures indicate that the fungi are now dead.

Root Diseases

Poria weirii root rot of Douglas-fir. Further analysis of data obtained in 1954 suggests that severity of infection may be closely correlated with stand density. This conclusion is not definite, however, since the basis was small and the 1954 studies were designed primarily to yield other information. The division plans to make thorough tests during the next few years because, if the conclusion is valid, it will probably make a reasonable degree of control of the disease practicable in Douglas-fir stands.

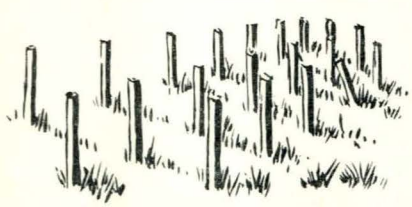
Phytophthora root rot of Port-Orford-cedar. The annual survey of southwestern Oregon for Port-Orford-cedar root rot (Phytophthora lateralis Tuck. & Milb.) was made jointly with the Oregon State Department of Agriculture. The disease has continued to spread within the natural range of Port-Orford-cedar and is now present along the coast from a few miles south of Reedsport to Port Orford. Inland from the coastal belt, it was found just across the Douglas County line between Remote and Camas Valley, near Tioga G. S., and between Myrtle Point and Powers. This disease has also been recorded near Brookings.

Decays and Stains of Forest Products

Prevention of decay in stored logs. A study was initiated to determine the effect of summertime sprinkling on rate of decay in cold-decked logs. Logs from two experimental cold decks were dissected and the decay estimated on a percentage basis. As a check on estimation, specific gravity was determined also.

The amount of decay in the green logs from the water-sprinkled deck was somewhat less than that in equivalent logs from the dry deck. For logs without bark, the difference was smaller. Temperature readings at different depths within the logs indicated that differences in temperature gradients were not sufficient to account for the difference in rate of decay. Estimated losses from hydraulic barking were recorded as supplementary information.

Tests of preservatives. In 1952, two plots of both treated and untreated stakes were established near Corvallis, Oreg., to determine the effectiveness of various preservatives against soil-inhabiting decay fungi. One plot is located in an open field without shade, and the other under the heavy shade of a forest cover. The first pronounced signs of decay became evident in 1955, and sample stakes showing representative decay in both plots were removed for culturing. Additional inspections and cultures will be made in 1956.



On-the-job treating tests. In 1952, various preservatives were applied to flooring and porch rails made from a number of different species. These were then exposed to the elements to determine the effectiveness of the treatments in prolonging serviceability of woods with low decay resistance. After three years of exposure, decay had not yet appeared. Plans for 1956 include preparation of the first report covering all annual inspections to date.

Diseases Not of Project Status

Top-dying of western hemlock. This division assisted other interested forestry agencies in an investigation of top-dying of western hemlock. Large acreages of old-growth hemlock types in northwestern Washington are involved. As a result of the investigation, top-dying was attributed to a complexity of causes, including overmaturity of the stands, climatic conditions, insects, and disease.

Top-dying of Douglas-fir. Top-dying of Douglas-fir has been fairly common in some localities during the past few years, and occasionally has progressed far enough to kill individual trees. Various parasites are associated with it, but the primary cause is probably a sudden drop in temperature. The sudden freeze last November is expected to result next year in an increased frequency of top-dying.

Miscellaneous. Diseases that are ordinarily of minor importance sometimes become temporarily abundant and damaging when weather conditions are favorable for their spread. For example, foliage rusts of species of Abies were favored by the wet summer of 1954 and became abundant enough in at least two localities in 1955 to impair the quality of Christmas trees. Since most of the 1955 growing season was also unusually wet, these rusts will probably be even more abundant in 1956.

Other diseases may become more destructive as wild stands are converted to managed ones. Cronartium comandrae, a native stem rust, is a killer of young 2- and 3-needle pines. It is seldom very destructive in natural reproduction, as enough trees usually escape infection to furnish adequate stocking. But it has caused serious damage to planted ponderosa pine, where the loss of even a few trees results in an undesirable reduction in stand density.

These examples illustrate the need for continuous accumulation of information on all diseases that attack the forest.

Cooperation

Many of the forest disease studies outlined in this report were made with the assistance of private, State, and other Federal organizations. Special acknowledgment is due the Central Oregon Chapter of the Society of American Foresters, Crown Zellerbach Corporation, Oregon Pulp and Paper Company, Oregon State Board of Forestry, Oregon State Forest Products Laboratory, Puget Sound Timber Company, Washington State Division of Forestry, West Coast Lumbermen's Association, Western Pine Association, Weyerhaeuser Timber Company, U. S. Forest Products Laboratory, and national-forest administrative officers in Washington, Oregon, and California.

Plans for Forest Disease Research in 1956

1. Continue nursery and plantation disease studies. The major task is to stop root rot losses in the 1-0 ponderosa pine seedbeds at the Bend Nursery.

2. Continue study of needle blight of ponderosa pine.

3. Complete blister rust study of mycelial extent and continue studies of canker growth and effectiveness of protective sprays.

4. Test additional sprays for the control of dwarfmistletoe.

5. Push studies of decay of insect-killed timber as rapidly as killed trees of known history become available.

6. In studies of Poria weirii root rot of Douglas-fir, keep major emphasis on rate and extent of damage to stands, but pay increasing attention to relationships that may eventually lead to control.

7. Keep abreast of the spread of Phytophthora root rot to commercial stands of Port-Orford-cedar.

8. Conclude cold-deck studies at Salem and publish results.

9. Continue annual examinations on flooring and rail durability tests and the ability of selected preservatives to withstand attack by fungi.

10. Give special effort to development of techniques so that an efficient, comprehensive program of forest disease surveys can be undertaken in this region as rapidly as finances permit.

FOREST INSECT RESEARCH

The Timber Resource Review reported approximately 1-3/4 billion board feet of commercial timber killed by insects in Oregon and Washington in 1952. Better methods of preventing and controlling epidemics that result in such losses would do much toward extending the timber supply of the region and the Nation. The work of the Station and its cooperators is designed to develop these methods.

In 1955, the Station continued its three-pronged attack on the insect problem through a program of research, survey, and control. Substantial advances were made on all projects.

Spruce Budworm Control

In the Blue Mountains of Oregon, almost 621,000 acres were successfully sprayed in 1955. This is hoped to be the concluding chapter of the 7-year-old effort to control the budworm. Since 1949, over 3.8 million acres have been sprayed at an average cost of $1.05 per acre, as shown in table 1.

Table 1.--Mortality and cost of spraying, spruce budworm control projects, 1949-55

Year	Acres treated	Cost	Cost per acre	Mortality (percent) Range	Average
1949	266,234	$ 320,000	$1.20	88.9-100	97.6
1950	933,702	990,000	1.06	90.4-100	99.2
1951	926,729	983,000	1.06	74.0-100	98.6
1952	655,111	681,000	1.04	81.8-100	98.2
1953	369,171	350,000	.95	88.5-100	99.1
1954	67,717	63,000	.93	96.3-100	99.0
1955	620,947	658,000	1.06	79.0-100	96.9
Total	3,839,611	$4,045,000		74.0-100	
Av. (wtd.)			$1.05		98.2

Significant accomplishments of this control program by private timber owners, the States of Oregon and Washington, and the Federal Government are as follows:

1. The epidemic, which started in 1944 and reached a peak of 2,276,000 acres in 1949, has been reduced to 542,430 acres in 1955.

2. Despite the large acreage of infestation, severe tree mortality has been confined to an area of 10,000 acres in northeastern Oregon.

3. Epidemic budworm infestations have been eliminated from western Oregon and the eastern Oregon Cascades.

4. Less than 1 percent of the treated acreage has had to be resprayed.

5. Recovery of defoliated trees following spraying has been remarkable and clearly proves the beneficial effects of spraying.

6. Aerial spraying to control the budworm on extensive areas has been proved practical.

Upon recommendation of the Northwest Forest Pest Action Committee, no spraying will be done against the budworm in 1956. The current infestation is less extensive and less threatening than at any time since 1946. Signs of increasing effectiveness of natural control indicate that the outbreak may soon be over.

Forest Insect Surveys

Epidemic infestations of major forest insect pests in Oregon and Washington were detected and appraised through two cooperative surveys in 1955.

Regional aerial and ground surveys of over 45 million acres were cooperatively conducted with many private and public foresters, including representatives of the Weyerhaeuser Timber Company, Oregon State Board of Forestry, and Washington State Division of Forestry. A marked decrease in losses caused by forest insects was found in 1955 over that reported the previous year. Some 2,248,820 acres of epidemic infestations were detected in 1955 as compared with 7,704,120 acres in 1954. A report, presenting survey findings, was prepared for distribution and review at the annual meeting of the Northwest Forest Pest Action Committee in October. The report was the basis for the committee's control recommendations for 1956.

The special survey of damage to Pacific silver fir by bark beetles was continued in cooperation with the Silver Fir Beetle Subcommittee of the Northwest Forest Pest Action Committee. Results of the survey and the work of the subcommittee were summarized and presented at the annual meeting of the parent committee. Work of the subcommittee included an incidental survey of areas of hemlock dying from unknown causes.

Improvement of Survey Methods

Plots for evaluating Douglas-fir beetle damage were rephotographed in color and field-checked for the third consecutive year. This will make it possible to measure the accuracy of estimating mortality by comparing repeat photographs. Analysis of the 1953 phase of this study showed that photographic interpretation of mortality, with some field checks, was cheaper than a complete ground survey of comparable accuracy. This was true of both panchromatic and color film, with use of color resulting in greater savings. Details of these findings were presented at the national meeting of the Society of American Foresters in Portland and will be published in the proceedings.

The use of aerial photographs to evaluate insect-caused mortality in the ponderosa pine type was studied cooperatively with the California Forest and Range Experiment Station. Preliminary results indicated that mortality survey costs can be substantially reduced by combining photo interpretation with some field checking.

Exploratory aerial photography of damage caused by the balsam woolly aphid was undertaken in cooperation with private industry. Although large-scale photography with color and camouflage-detection films showed damage not easily seen from the ground, a complete evaluation of the technique will require further photography and field work.

An improved model of the portable light-table for stereoscopic examination of color transparencies in the field was designed and constructed. Illumination was doubled and assembly made easier.

Laboratory experiments on processing aerial color film indicated that the effective film speed can be increased by 150 percent. This will enable aerial color photographs to be taken at faster shutter speeds than has previously been possible, thus reducing image motion.

Modern processing facilities for aerial and ground photography in both color and black and white were constructed in Portland. This makes it possible to virtually eliminate variations in processing as a factor in the evaluation of photographic techniques.

Spruce Budworm Studies

Studies of natural control factors were continued both in unsprayed areas and in areas sprayed during 1949-50. In unsprayed areas, studies of a continuing nature were improved by more intensive sampling of smaller plots and by a sampling study of tree foliage distribution. Also, two long-range studies were initiated: (1) The pattern of budworm dispersion and (2) budworm mortality occurring during hibernation. In sprayed areas, the number of plots was reduced by selecting only those most likely to provide population data and sampling them more intensively.

Studies of population trend and parasitism in four unsprayed study areas showed that aggregate parasitism was significantly higher than for previous years, considering the degree of infestation. During the sampling study, data were obtained to determine the distribution of foliage on trees with diameters within prescribed limits. In addition, a restricted number of the same trees were sampled for distribution of spruce budworm larvae on the tree. Distribution of foliated branch area was found to agree with a theoretical distribution according to the surface of a cone. Distribution of larvae was found to be independent of foliated branch area for the light infestation studied.

In the sprayed areas, population estimates were obtained only for larvae feeding in the opening buds. Parasitism was determined also for this stage alone. Sampling only in areas of relatively high residual population led to the recovery of a larger number of larvae than previously and provided a better basis for determining population trend and parasitism.

Overall, prospects for natural control in unsprayed areas are much better than previously. Parasitism of full-grown larvae is relatively high, as compared with recent years. One parasite, Meteorus trachynotus, normally an indicator of increasing natural control, was reared from the budworm in Oregon and Washington for the first time.

In cooperation with Walla Walla College, supervision was given to a study of the life history and general morphology of the spruce budworm on lodgepole pine. A progress report on this work will soon be issued by the college.

Douglas-fir Beetle Studies

Research on the Douglas-fir beetle continued as a cooperative undertaking with the Oregon State Board of Forestry and the Weyerhaeuser Timber Company. This cooperation speeds progress on priority jobs and eliminates duplication of effort.

Two new studies of the beetle were undertaken this year by the division. One study was to determine whether slashings in clear-cut areas serve as breeding material for beetle outbreaks; the other, to establish whether the beetles prefer trees infected with butt or heart rot to sound trees. Although the data from these studies have not been analyzed, it was observed that most slash in clear cuts dried out before beetle broods could complete development. Some successful broods were found in slash near shaded edges of the clear cuts and on the bottom sides of large, thick-barked, cull logs that were left after logging. From the second study, it appears that the beetles attack green trees as readily as rot-damaged ones.

A cooperative mortality study, established in 1946 with the Weyerhaeuser Timber Company, was continued. The study is being conducted on permanent plots in a 180-year-old stand in Coos County, Oreg. Mortality, exclusive of blowdown, has varied from 35 to almost 5,000 board feet per acre per year. More than 80 percent of the mortality during the study period has been attributed to insects, primarily the Douglas-fir beetle. Mortality on the plots in 1955 dropped to a very low level.

Silver Fir Beetle Studies

The outbreak of these beetles (Pseudohylesinus spp.) that has been in progress in northern Washington for the past seven years, dropped sharply in 1955. From a peak of 652,000 acres in 1954, the area of infestation dropped to some 114,000 acres and the intensity of infestation on this remaining acreage is much reduced.

With the addition to the Station staff of an entomologist who was assigned full time to the project, intensive research was started on the biology and ecology of the silver fir beetles. Through the use of trap trees and caging studies, considerable information was obtained on their feeding and attack habits. Studies of overwintering adult beetles found them to be in flight in early June. Shortly thereafter, they attacked and laid eggs that produced brood. Attacks by these adults continued at a decreasing rate throughout the season. Whether or not a second or overlapping brood is produced the same season is yet to be established.

Observations indicate that the moisture content and degree of deterioration of the tree cambium are critical factors in brood development. Attacks by adult beetles in which they only fed on the cambium and did not produce brood were found throughout the season. This appears to be a common habit, the importance of which is yet to be determined. Biological studies to date show that the life cycle of the two species of Pseudohylesinus involved is considerably more complicated than previously thought.

Studies were carried out to compare brood production in slash laid down at different times of the year, and in slash from different kinds of logging. The results of these studies indicate that more brood is produced in slash laid down in the spring than in slash laid down during the summer. Attacks and brood production were heavier in slash in selective logging areas than in slash in clear-cut areas. In selectively logged areas, brood was found abundantly in slash of all sizes, regardless of exposure. In clear-cut areas, brood was found in only a few cases, and then always on the protected side of pieces of slash over 6 inches in diameter.

Cooperative plots established in 1954 to record beetle trends were reinventoried and evaluated. Fifty-nine plots were eliminated for various reasons. On the remaining 395 plots, the infestation showed a sharp decline. In nearly all cases, mortality is now at a very low level.

Cooperative studies on rate of deterioration of beetle-killed silver fir were continued. From the entomological standpoint, it was found that borers frequently penetrate beyond rot and thereby are a factor in the deterioration of the wood.

The Silver Fir Subcommittee of the Northwest Forest Pest Action Committee continued to provide leadership and guidance for research and survey efforts on the silver fir beetle problem. Subcommittee members met in both spring and fall, and an annual report was presented to the parent committee.

Balsam Woolly Aphid Studies

Exploratory studies of the woolly aphid to determine its distribution, habits, and importance were continued. In southern Washington, it continues to kill Pacific silver fir extensively. In the Cascade Range of Oregon, either it or a near relative is killing subalpine fir. Two insect predators of potential importance have been found associated with the woolly aphid on subalpine fir.

Plans for Forest Insect Research in 1956

Three main activities--research, surveys, and technical supervision of control--will be continued in 1956. Studies on improvement of survey methods will continue to be jointly conducted with the Division of Economics. Studies of deterioration of Douglas-fir and Pacific silver fir will continue with the Division of Forest Disease Research. The following major projects are planned:

Spruce budworm studies

1. In unsprayed areas, continue studies of population and parasitism trends, foliage and population distribution on Douglas-fir, and population dispersion.

2. In sprayed areas, continue population surveys and estimates of parasitism for one developmental stage.

3. Summarize through 1955 the accumulated studies of natural control of the spruce budworm and prepare for publication a list of spruce budworm parasites in Oregon and Washington.

Douglas-fir beetle studies

1. Continue studies of relationships between stand conditions and beetle outbreaks.

2. Continue long-term studies for evaluating mortality in Douglas-fir stands.

3. Initiate studies to determine effects of climatic factors on beetle flight, attack, and brood development.

Silver fir beetle studies

1. Continue studies of biology and ecology of the beetles.

2. Expand studies of brood production in different types of host material.

3. Continue study of beetle-host relationships.

Balsam woolly aphid studies

1. Summarize study plot data.

2. Reinventory study plots.

3. Continue periodic test flights to determine best time for aerial detection of damage.

4. Continue biological studies.

Improvement of survey methods

1. Continue analysis of studies in Douglas-fir region and report results.

2. In the ponderosa pine region, continue studies to improve techniques. Test current techniques on an operational basis and report results.

3. Assess value of low-altitude oblique aerial photos for appraisal of insect outbreaks.

Surveys

1. Coordinate and participate in the regional forest insect survey and prepare the regional survey report.

Technical supervision of control

With no spruce budworm control in 1956, this activity will occupy a much smaller place in the division's program than heretofore. This service will be given when control of other pests is needed.

WATERSHED MANAGEMENT RESEARCH

Highlight of the year in the field of water investigations at the Pacific Northwest Station was the creation July 1 of the Division of Watershed Management Research. Marking the beginning of watershed investigations as a distinct function, it came after many years of effort, dating from 1937 when the Station first became involved in flood control activities. The first task was to recruit a staff and formulate specific project plans. At present the staff is small and the scope of the program will be somewhat limited for the next few years, at least.

Fortunately, however, some expansion beyond original goals has been made possible by funds obtained for cooperative investigations. Help has come from two sources. In November, an agreement was signed with the City of Portland Water Bureau launching a jointly financed study in the Portland water supply area. A second agreement has been reached with the Pilot Rock Lumber Company that will provide funds for a study of lodgepole pine watersheds in the Blue Mountains of northeastern Oregon.

A New Look

During the past year, considerable effort has been made to determine the current status of America's basic resources. Attention has largely centered on the nationwide Timber Resource Review, but some careful appraisals have also been made of water supplies.

One such analysis is contained in a report by the Governor's Water Resources Committee made to the Oregon State Legislative Assembly in January 1955. Water, the Committee emphasized, is one of Oregon's basic sources of wealth and demands for it are increasing at a significant rate. As an outgrowth of the Committee's recommendations, action has been taken to streamline State laws and governing bodies dealing with water problems in Oregon.

The U. S. Department of Agriculture chose the subject of water for its 1955 Yearbook of Agriculture. In this comprehensive review, there are 95 chapters, each pertaining to some phase of the water resource. Two chapters were contributed by members of this Station.

In November, a nationwide Forest Service conference was held in Denver, Colo., to review the current status of watershed management knowledge and practices employed by the Service and to set up guides for future efforts. Research was given prominent consideration and a set of recommendations for watershed research activities was formulated.

Water in the Pacific Northwest

Water, as well as timber, will be called upon to meet increasing demands in the next 25- and 50-year periods envisioned by the Timber Resource Review. By the year 2000, requirements will directly reflect new highs in population, industry, and agriculture. A recent study by Oregon State College indicates that the number of irrigated acres in Oregon will jump from the 1950 total of 1,367,707 to over 2.8 million by the year 2000. Similar trends are expected in the State of Washington. Pulp and paper production, aluminum manufacture, food processing, glass making, and oil refining are also increasing their water demands. These industrial processes require tremendous quantities of water.

It is the same story for our personal needs. Some forecasters predict that the upswing in Northwest population will maintain the 40 percent growth obtained between 1940 and 1950. Municipal water systems and sources of supply will be hard pressed to meet this growth in demand.

Current inventories show that the annual water yield in the Northwest is well above that needed to supply foreseeable demands. Available supplies cannot be fully used, however, because they are not uniformly distributed through the year nor equally apportioned on the east and west sides of the Cascades. Much of the winter and spring runoff is not used. In fact, this excess water often creates floods that tear out roads, wash valuable soil off the land, muddy water supplies, and deposit unwanted sediment on spawning beds and in irrigation ditches.

How are these problems to be met? Total water supply, unlike total timber supply, cannot be affected by management. However, we may be able to increase efficiency of use. Management practices on forest and grazing lands will influence the regularity of waterflow. Furthermore, it is possible to alter the amounts of water available for streamflow by decreasing the use made by some forms of vegetation. And usability of water can be improved, too, by reducing stream sediment contributed by eroding forest and rangelands. Research is needed to work out the application of this basic knowledge--to find ways of increasing summer waterflows and to learn how to minimize erosion caused by road building, logging, fire, and grazing.

Erosion From Logging

Logging methods compared. One of the first attempts to measure extent and kind of soil erosion from logging was made a few years ago in the ponderosa pine type of eastern Oregon and Washington. In this study, first reported in 1951, the three logging methods considered were horse, jammer cable, and tractor. The objective was to determine the influence of each method on the capacity of the logged area to produce forage.

In the fall of 1955, soil disturbance information was obtained for a fourth logging method, the Wyssen Skyline Crane. This Swiss-developed overhead cable system shows promise of substantially reducing soil disturbance. Its adaptability to American logging conditions is now being tested in a few places in this country, one of them on the Okanogan National Forest near Twisp, Wash.

Measurements from the Twisp operation must be considered preliminary since only one location is available. Still, they indicate that soil disturbance by the Wyssen Skyline Crane is mostly less than that by the other three methods. For the comparison, three types of disturbance were recognized: (1) Deep soil disturbance--soil displaced or torn up to a depth of one inch or more, (2) shallow soil disturbance--litter, humus, and tops of herbaceous plants cleared away and soil displaced or torn up to a depth of less than one inch, and (3) slash covered--ground surface covered by slash and logging debris.

Percent of Ground Surface Affected by Three Types of Disturbance From Four Logging Methods

Type of disturbance	Wyssen Crane (1955)	Horse (1951)	Jammer cable (1951)	Tractor (1951)
Slash covered	5.0	4.8	14.7	5.1
Shallow soil disturbance	0.7	9.5	13.3	5.9
Deep soil disturbance	1.5	2.3	1.9	15.0

Watershed study includes slash burning. In July, a study of erosion on logged-over areas on the Corvallis watershed was begun in cooperation with Oregon State College. The Corvallis watershed is an example of a municipal drainage from which both water and timber resources are being obtained under planned management. Questions have arisen regarding the amount of erosion induced by logging and slash burning and some answers will be provided by this study. Its purpose

is to determine what percent of the sample clear-cut areas have been disturbed by logging and by severe and light slash burning, and how the soils in these categories compare with undisturbed soils in adjoining uncut stands. Measurements are being made of the physical properties that influence erosion. These data are intended to measure the effect that logging and slash burning have had on soil properties associated with erosion.

Increased Runoff From Snow?

Are there opportunities in the Pacific Northwest for increasing the accumulation of snow and prolonging snowmelt in forest areas? Research in Colorado and southern Idaho has indicated that some types of timber cutting lead to gains in the amount of snow water available for streamflow. In the Northwest, the Douglas-fir, lodgepole pine, and mixed-conifer types may also offer opportunities for practical increases in snow accumulation. Primary objective would be to arrive at a method of timber harvest and intermediate cutting that would improve water yield as well as increase wood production.

The recent cooperative agreement with the Pilot Rock Lumber Company will provide an opportunity for a combined study of forest, watershed, and range management in the lodgepole pine type of the Blue Mountain area of Oregon. In this study we shall be seeking ways to increase production of wood fiber, add to streamflow by allowing more snow to accumulate, and augment forage for livestock.

Cattle Management-Erosion Study

During the summer, installations were completed at the Starkey Experimental Forest and Range for a study of the effect of cattle grazing on erosion. Eroded material is being measured in sediment catchment basins in six cattle-management pastures. The basins receive runoff from natural watersheds averaging about 50 acres in area, each with a mixed cover of timber and grass.

Soil disturbance will be evaluated primarily on the basis of sediment caught in the basins. However, supplementary records are planned to determine production and utilization of vegetation and changes in the amount of exposed soil.

This study is a supplement to a cattle-management study begun earlier in the summer. Following two years of uniform use by cattle, three intensities of grazing--light, moderate, and heavy--were applied on the pastures. For each grazing intensity, two systems of cattle management are being tested: Season-long, and deferred and rotation.

Municipal Watershed Study

The problems of watershed management in undisturbed city watersheds will be studied in Portland's Bull Run drainage beginning early in 1956. This has been made possible through a cooperative agreement whereby the City of Portland will provide financial assistance for a 20-year research project. The objective is to provide a sounder basis for management of the city's water supply. Since 1892, the only form of watershed management on this 102 square-mile drainage has been exclusion of human use, including grazing of livestock.

The basis for the final agreement is a plan outlining two principal problems, first of which is the need for more water. Eventually, Portland and its environs will outgrow the presently available supply, which the Water Bureau is now seeking to increase by creating added reservoir capacity. The plan suggests the additional possibility of gaining more water by careful cutting of the dense old-growth stand.

The second problem is the need to keep the water clean. Protection of the drainage has been complete only with respect to human disturbance. Natural catastrophes such as fire, insects, disease, and blowdown are becoming a stronger threat as normal forest uses continue to develop around this isolated body of old-growth timber. If the protective cover is suddenly destroyed, the city needs to know the best means of quickly restoring it.

Four studies have been proposed as a basis for watershed practices designed to augment available supplies of water and sustain its purity:

Snow storage. To determine the effect on snow accumulation and melting rate of (1) forest openings of various sizes, shapes, and positions; and (2) snow fences and other types of artificial barriers.

Runoff. To get a more accurate measure of the timing and quantity of streamflow and to evaluate any changes in waterflow that might result from timber cutting.

Soil. To determine the variation in potential erosion hazards. This study will be based on an analysis of the physical properties of soil types that are possible to delineate on a soil map.

Erosion control. To develop techniques for minimizing soil erosion and preventing loss of soil stability that may occur from any possible source in the Bull Run watershed.

Plans for Next Year

1. Prepare for a study of logging with the Wyssen Skyline Crane at H. J. Andrews Experimental Forest. One of three matched experimental watersheds will be used to permit accurate measurement of streamflow and sediment movement. A second watershed will be logged by conventional high-lead methods and the third will be used as a check.

2. Complete the initial study of how logging affects soil erosion in the Corvallis watershed.

3. Continue to measure the effects of cattle grazing on erosion at the Starkey Experimental Forest and Range.

4. Initiate a study of how logging in lodgepole pine affects accumulation and melting of snow and seasonal changes in soil moisture.

5. Make a reconnaissance examination of soils in the Mid-Columbia Research Center Province to determine recognizable variations in erodibility that will influence watershed management.

6. Select locations for stream gaging stations on experimental watersheds in the mixed-conifer timber type of the Mid-Columbia Province.

7. In the Bull Run watershed, select experimental drainages and prepare for installation of stream gages.

8. Plan for a study of erosion from road building in the Willamette and Mid-Columbia Provinces.

RANGE MANAGEMENT RESEARCH

A major achievement of 1955 was the completion of physical facilities needed for grazing studies on the Starkey Experimental Forest and Range. All fences were completed and permanent plots were established in all experimental pastures. Different systems and intensities of grazing were applied on 12 pastures, and initial inventories of vegetation and ground cover were made. First-year weight gains of cattle under different grazing treatments were obtained.

Arrangements were completed for a study, in cooperation with the Pilot Rock Lumber Company, that would include range management research on lodgepole pine lands in the Blue Mountain Research Center area. The study of relationships between timber harvest and forage production was continued with the seventh year observations on the Umatilla transects. Loss of a permanent staff member to the Armed Services in April limited activities on the range condition and trend project in the Blue Mountain Research Center area.

Studies of forage utilization by big game were started on two game pastures on the Starkey Experimental Forest and Range. Excellent progress was also made in the establishment of herbage production, forage utilization, and soil cover sampling units in experimental watersheds. These watersheds are being studied to determine the effect of grazing intensity on soil erosion from ponderosa pine ranges.

A highlight of the summer field season was the re-examination and photographing of plots established by Dr. A. W. Sampson, University of California, on the Wallowa National Forest in 1907. Range Management Research personnel participated in the trip with Dr. Sampson, along with grazing staffmen from Portland and from the Wallowa-Whitman National Forest. Some remarkable vegetation changes since 1907 have occurred in the green fescue zone where the original records and photographs were taken. Publication of the results is planned.

U. S. Department of Agriculture Farmers' Bulletin No. 2091, "Seeding Summer Ranges in Eastern Oregon and Washington," was issued in October. It includes guides for reseeding in sagebrush, pine-grassland, mountain meadow, and subalpine grassland types. Guides are

also given for seeding areas disturbed by logging and construction, and areas accidentally burned in forested zones.

Other activities of the Range Management Research staff included papers on grazing management and range ecology presented at meetings of the American Society of Range Management, Society of American Foresters, and American Institute of Biological Sciences. Participation was continued in the work of the Committee on Economics of Range Resource Development, which is a part of the Western Agricultural Economics Research Council.

Grazing Management Studies

Development of physical facilities for the grazing management study on the Starkey Experimental Forest and Range was completed during the year. The study of three rates of stocking and two systems of management was continued for the second year on the first block of six pastures, and started on the second block of six. Initial inventories of vegetation and soil cover were made, and data are now being compiled and analyzed. A permanent sampling system was established in each of the game pastures.

Cattle weight gains. Heavy grazing during 1955 produced average weight gains of 180 pounds for calves, as compared with 196 and 208 pounds for moderate and light grazing, respectively (table 2). Cow gains followed the same pattern, with heavy grazing producing 55 pounds of gain, as compared to 74 and 87 pounds for moderate and light grazing, respectively.

Table 2.--Weight gains of cows and calves under three grazing intensities 1/ and two systems of management during 1955

Grazing intensity	Gain--Cows				Gain--Calves			
	Deferred-rotation	Season-long	Average	Daily	Deferred-rotation	Season-long	Average	Daily
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Light	87	87	87	0.84	206	209	208	2.00
Moderate	74	73	74	0.71	192	200	196	1.89
Heavy	43	68	55	0.53	176	185	180	1.73
Av. (wtd.)	64	74			189	196		
Daily	0.62	0.71			1.82	1.89		

1/ Light = 10 acres per head per month; moderate = 7½ acres; heavy = 5 acres.

Average calf gain under season-long management was 196 pounds, as compared to 189 pounds under deferred-rotation management. Analysis of weight-gain data showed no significant difference attributable to system of management. Comparison of cow gains from individual pastures shows no difference in gain between season-long and deferred rotation management for the light and moderate rates of grazing. Under heavy grazing, however, season-long management produced an average gain of 68 pounds, while cows on deferred-rotation pastures gained only 43 pounds.

Total production of beef per acre was slightly higher on heavily grazed than on moderately grazed pastures. Four heavily grazed pastures, stocked with 98 cows and calves, produced 11.3 pounds per acre. Eighty-one head under moderate grazing produced almost as much, 10.1 pounds per acre. Sixty-two head on lightly grazed pastures produced 7.3 pounds per acre. Although individual animal gains were higher under moderate and light grazing, the larger numbers of animals on the heavily grazed pastures resulted in greater total gains.

Forage utilization. In order to obtain the weight gains shown above, cattle on heavily stocked pastures in Block I utilized approximately 65 percent of the bluebunch wheatgrass during the 1955 grazing season. A complete utilization inventory of this block of pastures was not made, owing to adverse weather conditions. Cattle utilized bluebunch wheatgrass 51 percent in a moderately stocked pasture, and 36 percent in a lightly stocked pasture. In this block of pastures, no difference in the utilization of the major forage species was observed under the two systems of management.

Utilization of bluebunch wheatgrass on the grasslands in Block II of the experimental pastures averaged 28 percent, 49 percent, and 50 percent, respectively, for light, moderate, and heavy stocking. However, this species is not as abundant as it is in Block I and cannot be used as a basis for determining stocking rates. Where it is found, it occurs as scattered individual stems and not as the bunch-type found in Block I. Other grassland forage species and their percent utilization under the various intensities of grazing are as follows:

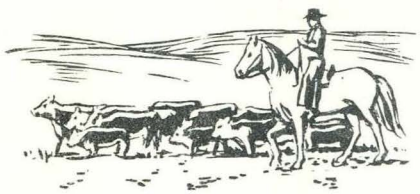
Species	Light	Moderate	Heavy
Bluebunch wheatgrass	28	49	50
Onespike danthonia	18	23	27
Sandberg bluegrass	13	15	14
Bottlebrush squirreltail	30	38	55
Letterman needlegrass	21	41	39

No real difference occurred in the utilization of these species under moderate and heavy intensities of stocking, excepting bottlebrush

squirreltail. This grass received 38 percent use under moderate grazing, and 55 percent use under heavy grazing.

Utilization of plants in the timber was light under all intensities of grazing. Use of elk sedge, the most important forage species in the open forest type, was as low as 2 percent in one of the lightly grazed pastures. Maximum use was 19 percent in a heavily grazed pasture. Light use of herbage in the open forest was due to rains in July and September, which provided green forage on the grassland openings.

Control of livestock movements. The effectiveness of a well-planned program of range riding for securing better distribution of cattle and more uniform forage use was tested on the Starkey Experimental Forest and Range during the 1955 grazing season. Due to this program, areas which formerly received relatively light use because of steep topography were moderately utilized. As a result, grazing pressure was reduced on areas of gentle topography, which had previously been heavily utilized. This shows that securing uniform distribution of cattle is dependent upon a thorough job of range riding, even though adequate salt and water are distributed on the range.



This year the Starkey Cattle and Horse Association employed a new range rider who was unfamiliar with the country and the way cattle had previously used the range. Early in the season, therefore, areas of natural concentration were shown to the rider by Blue Mountain Research Center workers. He was also shown areas where it was difficult to obtain good forage use because of steep topography. The salting plan and locations of livestock watering places were reviewed on the ground. A plan for visiting these areas to inspect salt use and condition of the stock water was developed with the rider.

Cattle were initially distributed into the higher, more remote areas where salt had been placed and water was not more than three-fourths of a mile away. They soon began drifting into lower country of gentle topography, even though salt had not been placed in these areas. To correct this, when the rider would inspect a salt ground or water hole in the steeper, more remote areas, he would take 50 to 100 head of cattle with him.

Cattle were trailed to watering places or salt grounds, forcing them to start trails. Salt grounds were established in new locations in an effort to make the areas more attractive to the cattle. Eventually a sufficient number of cattle remained to make efficient use of the forage. On one 800-acre area, salt use was increased from 250 to 400 pounds. In previous years, bluebunch wheatgrass and elk sedge, the more important forage plants, received an average of 30 and 10 percent use, respectively.

In 1955, bluebunch wheatgrass was used 50 percent and elk sedge 25 percent. This increased use reflected the direct effect of a good range riding job.

Big-Game Ranges

In 1955, two 100-acre pastures were constructed to study the forage-use habits of deer and elk on the Starkey Experimental Forest and Range. These pastures were fenced to exclude livestock, but to allow as much free movement of big game as possible. The pastures have the threefold purpose of determining (1) what forage species are used by big game, (2) when and how much of the various forage species are utilized, and (3) the correlation between pellet-group counts and actual forage use. Information from these pastures is used to determine the amount of forage used by big game in the pastures grazed by big game and cattle.

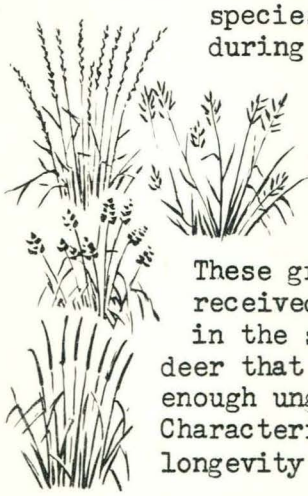
Use of forage by big game in the experimental pastures, as determined by pellet-group counts, was greater in 1954 than in 1953. In 1953, total game-days of use in the 12 experimental pastures by deer and elk was 17,684. Game-days of use in 1954 increased to 29,753, an increase of 12,069 days' use. This is equivalent to a 10 percent increase in rate of stocking on each of the experimental pastures. These figures emphasize the importance of making allowances for big-game use when determining stocking rates of ranges used jointly by big game and cattle.

Big game used the open forest range more than the grasslands. Elk, however, used the grasslands to a greater extent than deer. Seventy-five percent of the deer use and 64 percent of the elk use were on open forest areas. Previous cattle utilization studies have shown that cattle obtain approximately 60 percent of their forage from the open forest. This emphasizes the need for information on competition or compatability between big game and livestock on summer ranges.

Soil treatments. Game-forage seeding for elk on the Snoqualmie National Forest continued to show the benefits of soil amending treatments. Superiority of seedbeds treated with sawdust plus nitrogen over nitrogen-treated and unfertilized seedbeds was apparent in the second growing season of Agropyron intermedium. The superiority of broadcast-and-cover seeding on sawdust-amended soil over drilled plantings also continued into the second growing season. The treatments alleviated the effects of low fertility, frost heaving, and drought that were known to handicap germination, emergence, and initial growth of plantings.

Some of the drilled plantings resulted in establishment of 1 to 3 plants per square foot in the first growing season on the subalpine study area. But growth and development expected during the second growing season failed to occur. Average height of best stands only reached 5.2 inches and the maximum height was 10 inches. Forty-nine plots out of 60 had fewer plants per square foot in the second growing season than in the first.

An attack by Pacific grass bugs (Irbisia pacifica) occurred in the spring of the second year and their feeding on spring growth probably helped retard grass development. Unknown factors also may have been partially responsible, since good control of the insects was obtained with malathion-lindane-DDD spray early enough to allow the grass to make additional leaf and height growth. In this case, spring and early summer soil conditions are believed to have retarded grass growth. These conditions are scheduled for investigation next year.



Most of the grasses studied in adaptability trials of game-forage species on the Okanogan National Forest continued to do well during their second growing season. Their height growth of 19 to 40 inches was phenomenal compared to the maximum of 10 inches growth on the seedbed study which was discussed earlier in this report. Grasses rated as best in the first growing season were excelled in the second year by Agropyron trichophorum, Bromus marginatus, Dactylis glomerata, and Phleum pratense. These grasses, with the exception of Dactylis glomerata, received the most spring use by deer. The legumes included in the study were so heavily utilized during the summer by deer that protection from game use had to be provided so that enough ungrazed growth would be available for observation. Characteristics remaining to be determined for each species are longevity and competitive ability.

Range Condition and Trend

Major emphasis on the Starkey Experimental Forest and Range was on the classification of sites within the grassland type. Each cluster of plots within the experimental pastures was classified according to tentative descriptions prepared by the Station in 1954. One additional site on ridge tops was recognized and described.

Analysis of soil cover data from the pastures of Block I shows that ridge sites have the least cover, with 46 percent of the surface covered by vegetation and litter (table 3). These sites are found on ridges with less than 5 percent slope, where soils are poorly drained and are six inches or less in depth. Production on ridge sites varies from 100 to 500 pounds of air-dry herbage per acre.

Table 3.--Soil cover on four grassland sites in 1954

Cover	Site			
	Ridge	IV (Slope)	III (Hummock)	Dry Meadow
	Percent	Percent	Percent	Percent
Vegetation	12	15	20	24
Litter	34	40	45	49
Bare soil	48	36	32	24
Rock	6	9	3	3

Comparison of square-foot density data collected in 1939 and soil-cover data in 1954-55 show an upward trend in density of vegetation on the Starkey Experimental Forest and Range. Density of vegetation increased from 11 percent in 1939 to 17 percent in 1954 on the grasslands of Block I. The greatest increases occurred on "scab ridges," where vegetation density more than doubled. In Block II, grasslands that had an average density of 13 percent in 1939 increased to 25 percent in 1955.

Condition standards. In central Washington, an urgent need was found for revision of condition standards for subalpine or green fescue types in the northern Cascade Range. Loop transect data obtained by experiment station and national forest personnel were combined to develop a tentative standard. In addition to the dominant, green fescue, considerable amounts of other desirable grass and grasslike plants were found. Certain forbs also formed part of the cover even on seemingly stabilized areas. Species were temporarily classified as follows:

Most desirable	Intermediate	Least desirable
Carex spp.	Arnica spp.	Achillea lanulosa
Calamagrostis canadensis	Bromus carinatus	Antennaria lanata
Elymus canadensis	Danthonia spp.	Arenaria spp.
Festuca viridula	Lupinus spp.	Erigeron spp.
Trisetum spicatum	Luzula glabrata	Eriogonum spp.
	Penstemon spp.	Phlox spp.
	Phleum alpinum	Phyllodoce empetriformis
	Poa spp.	Potentilla spp.
	Stipa columbiana	Senecio spp.
	Veronica cusickii	Vaccinium spp.

The small amount or absence of lupine under a variety of conditions was unexpected. This important point needs further investigation.

Northern Cascade Range subalpine ranges in best condition have the following general species composition:

Festuca viridula	45 percent
Carex and secondary grasses	25 percent
"Intermediate" grasses and broad-leaved herbs	30 percent

The tentative standard developed is now being used by the Okanogan National Forest but further reconnaissance and study is needed. More information is particularly needed as to type changes with variation in exposure, slope, and soil.

Timber-Grazing Relationships

Immediate losses of forage on logged areas and degree of soil disturbance have been reported before. The second phase of the logging study (succession of herbaceous and shrubby plants during the first 7 years) is nearing completion.

Progress of secondary succession has varied among areas sampled. In the second year after logging, the broad-leaved herbs invariably started to increase. In some instances, grasses and shrubs continued their decrease into the second year. By the fourth year after logging, weeds were still increasing and rebuilding of grass and shrub cover had started. This flush of growth was sufficient to restore total plant cover but the herbaceous vegetation was predominately broad-leaved herbs. In one area an invasion of inflammable cheatgrass also depreciated the value of the new plant cover.

Seventh year data are still incomplete but a new trend appears to be developing. Amounts of broad-leaved herbs have declined on two transects, and on the third gains have been slight. This trend, coupled with near recovery of grass and shrub groups, may mark the end of major changes in understory cover.

Ecology of Elk Sedge

Elk sedge produced 44 percent less herbage in 1954 than in 1953 on the Starkey Experimental Forest and Range. The reduction was uniform over all treatments and could not be attributed to intensity or date of harvest. Poor distribution of rainfall and higher maximum temperatures in 1954 during the spring growing period were largely responsible for the decreased production.

The late dough stage of seed development appears to be a critical period in the life cycle of elk sedge. Herbage removal during this period,

regardless of intensity, has reduced the number of seed stalks produced the following year. Grazing use at this time should be minimized on timbered ranges where elk sedge is important as a forage species. The late dough stage of development usually occurs during the first two weeks of the summer grazing season.

Removal of 60 percent of the current year's herbage continued to reduce elk sedge vigor after two years of treatment. Numbers and heights of seed stalks were reduced. Under the 40 percent harvest, 1.8 times as many seed stalks were produced as under the 60 percent harvest. The 20 percent harvest resulted in twice as many seed stalks as were produced under the 60 percent harvest. Seed stalks were 0.6 and 0.8 inches longer under 20 and 40 percent intensity, respectively, than under 60 percent herbage removal.

Range Measurement Techniques

In central Washington, no additional study of range measurement techniques was made in 1955. Assistance, however, was given national forest officers in adapting previously developed research techniques to use on administrative projects.

Use of Fire in Range Improvement

For the second year following prescribed burning of jungled pine and ceanothus range on the Colville Indian Reservation, the amount of grass has continued to increase. Amount of grass cover is now 53 percent greater than before the burn. This is mostly the result of a 74 percent increase in density (or coverage) by pinegrass. Change in grass cover was, at least in part, an expression of release from dominance of snowbrush ceanothus and pinemat manzanita.

Initial gains in cover of broadleaved herbs were partially lost in the second year following burning. Increased competition from other plants and a 35 percent deficit of precipitation from the norm contributed to the reduction of herbs. Most of the change was confined to a 77.4 percent reduction in lupine.

Although shrub cover was reduced 42 percent by the fire, snowbrush ceanothus and pinemat manzanita produced new shoots and by the second year had replaced large parts of their crowns (table 4). The ability of these shrubs to recuperate from fire damage appears to be so good that gains made by herbaceous plants may soon be restricted by renewed competition from shrubs.

Table 4.--Density of range vegetation and percent change following fire

Class of vegetation	Before burn	After burning			
		1st year		2nd year	
		Density	Change	Density	Change
	Percent	Percent	Percent	Percent	Percent
Grasses	3.40	4.37	+ 28	5.20	+ 53
Broad-leaved herbs	1.34	5.26	+ 292	3.18	+ 137
Shrubs	10.02	5.84	- 42	8.76	- 13
All herbage	14.76	15.47	+ 5	17.14	+ 16

Mortality of trees over one foot in height increased 68 percent in the first growing season. In the second growing season, mortality increased to 83 percent over the original amount resulting from the burn. This will increase accessibility of the range for livestock when the stems and branches deteriorate.

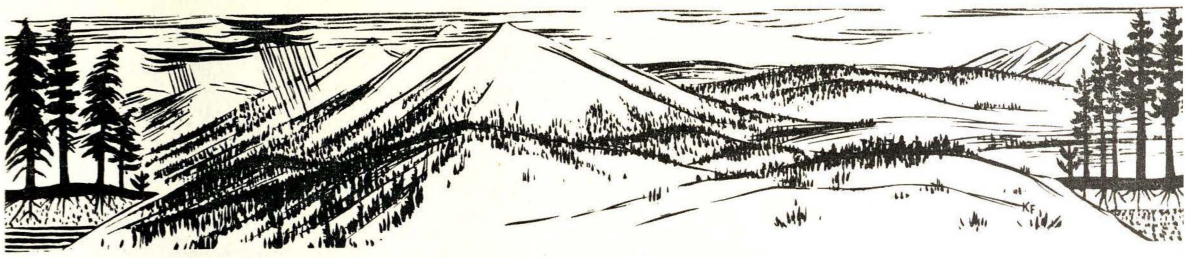
Plans for Range Management Research in 1956

Plans for 1956 call for continuation of all existing studies excepting the rodent-range relationships project, which will be terminated upon publication of results in the Journal of Range Management.

A range problem analysis for the Mid-Columbia Research Center Province is scheduled for completion. Also, a multiple-function problem analysis for the Blue Mountain Research Center Province will be prepared. This will require revision of the present range problem analysis and compilation of additional material on problems relating to water and forest resources.

At Starkey, emphasis will be placed on the completion of vegetation inventories on the game pastures, and initiation of utilization studies to determine degree of use and preference for forage species by big game. Compilation and analysis of herbage production and soil cover data collected in 1954 and 1955 will be completed. Further attention will be given to revision of condition and trend standards for bunchgrass and dry meadow sites.

In the Mid-Columbia area, in addition to continuation of existing studies, revision of condition and trend standards will be extended to major variations of subalpine range, with reference to effects of exposure, slope, and soil changes. The survey of logging disturbances of range vegetation will be extended to include effects of the Wyssen system.



FOREST MANAGEMENT RESEARCH

Forest management problems continued to receive attention at 4 of the Station's 6 research centers during 1955. At the Puget Sound Center, main effort was again directed toward improved practices in management of young-growth Douglas-fir. Studies at the Willamette Center were divided about equally between management of old-growth Douglas-fir and young-growth spruce-hemlock. Mixed pine-fir forests of southwest Oregon came in for primary attention at the Siskiyou-Cascade Center and east-side ponderosa pine held the spotlight at the Deschutes Center.

Research attack at the centers was backed by three regional projects; one each in forest genetics, forest soils, and fire studies.

Most of the key findings from all these efforts were fully reported in the 33 forest management publications that were released by the Station during 1955. Some of the other facts and indications disclosed during the year but not yet published are summarized in the paragraphs that follow.

Old-Growth Douglas-fir

Regeneration on south slopes. Previous studies on the H. J. Andrews Experimental Forest showed that a high percent of available seedbeds on south-slope clearcuttings were subject to surface temperatures lethal to Douglas-fir seedlings. This past year, trials of artificial seedbeds showed, among other things, that temperatures are cooler and survival better on white sand than on yellow mineral soil, the best natural seedbed. First attempts at sowing mustard as a cover crop to shade the seedbed were not successful, but this approach is also believed to merit further study.

Logging costs. In 1955, logging cost data collected during the harvest of some 60 million board feet on the H. J. Andrews Experimental Forest were critically studied. The analysis, carried out by Professor John Carow, School of Natural Resources, University of Michigan, showed that costs on the experimental area were well in line with regional averages. Efficiency in felling and bucking showed a steady increase during the 5-year study period. In 1950, 1.05 man-hours were required per thousand board feet, compared to 0.87 man-hours in 1954. The shift from

a 2-man to a 1-man felling crew and continual improvements in power saws are believed responsible. Felling and bucking costs averaged $3.80 per thousand board feet (net scale) during the 5-year study.

Tractor yarding cost less than high-lead yarding. In part, this was because tractors were used only on the most favorable ground with heaviest timber volume and largest logs. Total costs of yarding with tractor and arch averaged $3.61 per thousand board feet including $1.83 for labor. In contrast, high-lead yarding averaged $5.24 including $3.64 for labor. Loading costs averaged $1.53 per thousand board feet for all units, and log hauling for a 50-mile haul averaged $11.30.

Costs of road construction, total of which ranged from $20,000 to $30,000 per mile, averaged $8.78 per thousand board feet harvested. This compares to a regional average of $5.11. Road costs on the H. J. Andrews were higher than average because a large part of the permanent road system, including three bridges, was built during initial development. The analysis indicated that logging costs vary greatly due to local situations or circumstances that cannot always be anticipated in planning or always explained after a sale has been completed. When estimated costs are based on either local records or regional averages, true costs apparently can be expected to vary as much as 10 to 40 percent.

Young-Growth Douglas-fir

Tetramine and WRL-2. Current results from a replicated test of rodent repellents on the Olympic and Siuslaw National Forests indicate that WRL-2 is highly effective in protecting Douglas-fir seed from destruction by rodents in direct-seeding operations. Although numbers of seedlings obtained on the two areas differed greatly, WRL-2 was at least as effective as tetramine. In some areas, WRL-2 appeared superior.

Seed production low. Seed fall in a 40-year-old Douglas-fir stand on the Voight Creek Experimental Forest has been measured for 6 years. The following record shows that during the last 5 consecutive years, seed production has been less than 1 pound per acre considered minimum for adequate regeneration:

Year	Cone-crop rating	Seed production (Pounds/acre)	Viability (Percent)
1950	Medium	2.20	37
1951	Failure	.33	10
1952	Failure	.25	0
1953	Failure	.02	20
1954	Light	.87	26
1955	Failure	.15	9

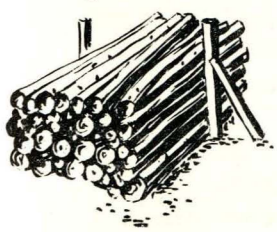
Such a long hiatus in seed production seriously restricts natural restocking and points up the necessity of reserving seed trees or seed blocks over prolonged periods to insure adequate natural seed fall. The low viability associated with low seed production makes most crops under three-fourths of a pound practically valueless. The record also emphasizes the necessity of carrying large reserves of seed for seeding and planting operations to tide us over periods when seed crops are consistently light or a failure.

Do dominant Douglas-firs respond to release? The answer is yes, according to third-year results in a well-stocked, 45-year-old stand in the Wind River Experimental Forest. In the study, 0, 1, 2, or 3 chief competitors were cut around 10 trees each in the dominant, codominant, and intermediate crown classes. The trees selected for study were in all cases widely enough spaced so that the spot thinning around a single study tree affected only that tree. Average 3-year diameter growth was as follows:

Competing trees cut (Number)	Dominants (Inches)	Codominants (Inches)	Intermediate (Inches)
0	0.69	0.43	0.19
1	.72	.56	.29
2	.94	.48	.33
3	1.05	.48	.31
Average	0.850	0.483	0.277

Most revealing is the prompt and substantial acceleration in diameter growth of released dominant trees on this site IV land. Further study is required to determine more precisely what kind of tree will respond best to release, as well as to determine the optimum level of release. Continued observation of the Wind River experiment should provide some of the answers and point the way to further research on others.

Plantation thinning increases yield. A cubic-foot yield 65 percent above normal for Douglas-fir was recorded in the 31-year-old Snow Creek plantation on the Olympic National Forest. A 5-acre experimental tract within the plantation was thinned for the first time in 1952, with a harvest of 5 cords of pulpwood per acre. Since thinning, gross annual growth (including salvable mortality) has averaged 300 cubic feet, or 3-3/4 cords per acre. Present merchantable cubic volume is 4,510 cubic feet, or 55 cords. The expected normal yield for this age and site index (150) is only 2,740 cubic feet, or 33 cords.



The increased yield in the plantation is attributed to wider and more uniform spacing (8 x 8) than occurs in natural, fully stocked stands. Repeated thinnings at 5-year intervals, which will sustain uniform spacing and salvage mortality, are expected to maintain a great part of this original yield advantage.

Reduced height growth immediately following heavy thinning. Precommercial thinning in a 23-year-old plantation of Douglas-fir resulted in reduced height growth the first two growing seasons after thinning. The first year after thinning, height growth was 62 percent of that in the season prior to thinning; in the second season, it was only 39 percent. In the adjacent unthinned stand, growth in the same years was 8 percent and 18 percent greater than in the year before the thinning was made.

These were very heavy thinnings, which completely released all reserve trees. The reduced height growth is thought to be direct evidence of shock to the residual stands.

Selection vs. low thinning. Selection thinning at King Creek shows some significant trends in comparison with low thinning after 6 years' experience. Starting with a 27-year-old stand, four selection thinnings were applied at 2-year intervals. This thinning, which removes only dominant trees, has resulted in a smaller residual tree, but has not reduced rate of growth. An average of 17 percent of the cubic volume was removed in each selection thinning. In contrast, 2 low thinnings at 4-year intervals averaged 10 percent removal. Because larger trees were cut, selection thinning offers immediate profit whereas low thinning has been done at some loss. Thus it is evident that selection thinnings may become commercially feasible at an earlier age, when the largest trees in a stand first reach merchantable size.

Studies at King Creek, as well as those on the nearby Voight Creek Experimental Forest, are a joint effort with the St. Paul and Tacoma Lumber Company.

Plywood from pruned Douglas-fir. This became a reality for the first time during 1955 in an exploratory trial in cooperation with Georgia-Pacific Plywood Company. Two trees in the Kugel Creek thinning plots, which had been artificially pruned in 1937, were cut and three 50-inch blocks sawed from the pruned portion of each tree. Then the blocks, averaging 15.5 inches in diameter and containing 2.2 inches of radial growth since pruning, were peeled and representative panels made from clear and knotty material. Although exact measurements were not made it was apparent that amount of clear-face stock produced was less than the volume that theoretically should have been available. Except for some torn grain, which presumably was due to type of lathe used, the clear panels were satisfactory from every standpoint.

Sitka Spruce-Western Hemlock

Research in this important fog-belt forest type is a cooperative undertaking--at the Cascade Head Experimental Forest with the Publishers' Paper Company, and at the Hemlock Experimental Forest with St. Regis Paper Company.

Planting on decayed wood. Previous observations at Cascade Head Experimental Forest had indicated that rotten wood provided a good seedbed for establishment of natural spruce and hemlock seedlings and inhibited development of competing brush species. These observations led to a test in 1953 of survival and height growth of stock planted on rotten wood in comparison with mineral soil. Since nursery-grown stock of western hemlock was not available, Sitka spruce and Douglas-fir were used. The experiment was replicated on north and south slopes. For both species, results thus far indicate no significant difference in either survival or height growth between rotten wood and mineral seedbeds. Above-average rains during the summer of 1953 probably contributed to high survival under all conditions.

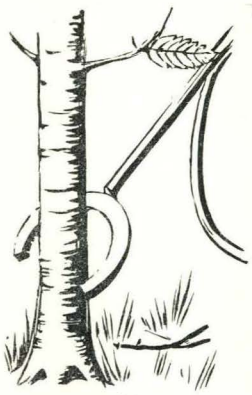
Decayed wood is generally avoided as a poor spot for planting because of rapid moisture loss during dry periods. Apparently the spruce-hemlock forests of the Coast Range are an exception to this rule, especially in years with cool, wet summers when frequent rains and fog provide ample moisture.

Slash burning helps establish planted seedlings. Evidence that slash burning aids in establishment of planted Sitka spruce was obtained from a test started in 1949 at Cascade Head. For both north and south slopes, sixth-year survival was highest on sites where slash had been burned prior to planting. This is shown in the following tabulation:

Slope	Survival in percent	
	(Burned)	(Unburned)
North	96	88
South	83	61

For south slopes, tree heights averaged 67 inches on both burned and unburned areas. For north slopes, planted trees averaged 88 inches on the burned site compared to 73 inches on the unburned. Differences obtained in both survival and height were attributed in part to reduced competition from brush on the burned area.

Chemical control of red alder through basal treatments. A study at the Cascade Head Experimental Forest has shown that red alder can



be killed by a basal treatment using 2,4,5-T in diesel oil. Basal treatments are particularly applicable for individual alder trees or small groups of trees on areas in the Oregon Coast Range being managed for production of conifers. In the study, 96 percent kill was obtained using a concentration of 32 pounds of acid equivalent per 100 gallons. Costs, including labor, were $.044 per tree.

A lighter concentration of 2,4,5-T, plus 2,4-D, also resulted in good kill and cost only $.031 per tree, which approximates the cost of hand slashing and girdling. Chemical control, however, apparently has the advantage of preventing resprouting.

All treatments were applied during the growing season when the alder stems were dry. Further research is under way to see if costs can be reduced by using other chemicals or lighter concentrations and to test dormant season treatments.

Chemical treatments to control salmonberry. Competition from salmonberry and associated brush species is a major obstacle to establishment of natural regeneration and plantation survival in the Oregon Coast Range. Studies started in 1952 have shown that foliage sprays will cause about 90 percent defoliation of salmonberry. However, scattered sprouts appear the first season followed by vigorous sprouting the next, which again overtops many conifers. Foliage treatments are being continued to screen new chemicals that become available.

In April 1955, at the end of the dormant season, a study was started to explore control of salmonberry by basal treatments. First season results were very encouraging since most treated plants did not leaf out or send up basal sprouts. Examination of roots showed considerable root kill. Additional treatments are planned to determine the best chemical and concentration to use. Basal treatments are best applied in the dormant season when the foliage is off the salmonberry plants.

Restocking brushy areas following clearcutting. Results discussed in preceding paragraphs are applicable not only to the spruce-hemlock forests but also to many Douglas-fir stands in the Oregon Coast Range. These results, plus accumulated findings from a number of related studies on burning, planting, and chemical control, suggest the following tentative recommendations:

1. Identify brush-threat areas before clearcutting and plan special treatments to insure prompt regeneration.

2. Apply treatments as soon as possible after logging.

3. Fell adjacent timber into brush patches to knock the brush down and provide slash to facilitate burning.

4. Plan yarding so that logs will be dragged through the brush patches.

5. Broadcast burn brush patches to retard brush development and clean up the area for planting.

6. Plant brush-threat areas as soon as possible to give trees a head start on the brush.

7. Plant the largest and most sturdy planting stock available.

8. Inspect plantation periodically and release trees being overtopped.

9. Slash or poison any red alder or willow that becomes established in the plantation area.

Commercial thinning. Trials were continued in both 100-year-old stands on the Cascade Head Experimental Forest and 55-year-old stands on the Hemlock Experimental Forest.

A current test at Cascade Head compares logging costs and damage between two yarding methods in a 15-percent thinning. One method employs a D-4 tractor operating from well-planned tractor roads. The other method combines a portable high-lead yarder for decking logs along tractor roads with a D-4 tractor for swinging logs to the landing.

At the Hemlock Experimental Forest, two 25-acre compartments were thinned for a second time. In one compartment, this thinning removed 8 cords of pulpwood per acre, including 82 percent of the mortality that occurred between thinnings. This was a light cut--8 percent of stand volume--removing trees that averaged only 9 inches d.b.h. Even so, the operation was highly successful, with the operator making a profit of $2.10 per cord after paying all expenses, including $2.50 for stumpage. Equipment included a power saw for felling and bucking, a horse for skidding, a farm tractor equipped with a fork lift for loading, and a short-bodied truck for the 15-mile haul. Average costs and time required to produce hemlock pulpwood, f.o.b. plant, in this thinning were as follows:

Item	Man-day per cord	Cost per cord
Felling and bucking	0.10	$ 2.38
Skidding	.21	4.64
Loading	.05	2.06
Hauling	.07	4.26
Total	.43	$13.34

These costs are well within current market prices for hemlock pulpwood.

Mixed Pine-Fir Forests (Southwest Oregon)

Regeneration survey. The 1954 South Umpqua drainage regeneration survey provided additional information during 1955 on the relationships between natural restocking and slope, aspect, seedbed condition, and amount of tree overstory. Coniferous seedlings in this area were mainly Douglas-fir with lesser numbers of sugar pine, ponderosa pine, incense-cedar, and other associated species. Stocking was generally found to be better:

1. Under a moderate overstory of residual trees than under a heavy overstory or in the open.

2. On steep slopes (over 15 percent) than on gentle slopes or level ground.

3. On north and east aspects than on south and west aspects.

4. On soil surfaces disturbed by logging than on undisturbed surfaces.

Germination and survival following a seed-tree cutting. This subject has been under study on two units of the Junction Springs sale in the South Umpqua drainage. On both units, all Douglas-firs were harvested in 1953 and all ponderosa pines and sugar pines were reserved from cutting in an attempt to favor pine regeneration. Following cutting, one area was poisoned to control rodents and increase effectiveness of natural seed fall. Germination in the spring of 1954 and survival at the end of the first and second growing seasons were as follows:

	12-acre unit (Poisoned)	20-acre unit (Not poisoned)
	- - - Number per acre - - -	
Seeds germinating, 1954	4,491	1,209
Seedlings alive, fall, 1954	2,983	1,056
Seedlings alive, fall, 1955	2,559	847

Good survival along with a gradual infiltration of new seedlings is providing satisfactory stocking on even the unpoisoned area within a very few years. Over 80 percent of the surviving seedlings are ponderosa pine. Future work on these areas will attempt to determine if the seed trees

can be harvested economically and without serious damage to the new crop of seedlings.

Regeneration of Shasta red fir. Evidence from one clear-cut unit had previously indicated that Shasta red fir can be restocked under the staggered-setting system of clearcutting. During 1955, a natural reproduction survey was made of nine additional units logged from 1950 to 1953 on the Kogap sale area of the Rogue River National Forest. Good seed crops occurred in the general area in 1951 and again in 1953. Six units were found to be well stocked, 2 medium stocked, and 2 poorly stocked. No units were classed as nonstocked. Stocking on unburned portions of the cutting units was found to be about $2\frac{1}{2}$ times greater than on burned areas.

Direct seeding in pine and fir regeneration. Direct seeding of sugar pine and ponderosa pine has been explored for several years in pilot tests in cooperation with the Umpqua and Rogue River National Forests. Results so far indicate that direct seeding may hold promise as an economical and successful method for obtaining pine regeneration after clearcutting. A 1953 seeding of sugar pine on a 25-acre tract in the Junction Springs area of the Umpqua National Forest is especially impressive. At the end of the second growing season, stocking averaged 75 percent. In this case, seed surface-coated with tetramine in dextrin was sown in spots at the rate of two seeds per spot.

A new study installed in the fall of 1955 is designed to determine optimum seeding depth for sugar pine, ponderosa pine, and Douglas-fir. Seeds were sown on the surface and at depths of $\frac{1}{4}$, $\frac{1}{2}$, 1, and $1\frac{1}{2}$ inches on three different soils. Results will be evaluated in terms of relative germination and first year survival.

A first trial of direct seeding Shasta red and noble fir was made on the Rogue River National Forest in 1954. The seeding did not result in satisfactory stocking. It demonstrated, however, that surface-sown seed of these species germinate and survive as well as planted seed.

Brushfield reclamation. An expanded program of chemical brush-control studies was undertaken in southwest Oregon during 1955. Efforts were directed along three lines of research attack:

1. Screening tests of available herbicides on a few of the most troublesome brush species of southwest Oregon.

2. Tests to determine season of year when problem brush species are most susceptible to chemical treatment.

3. Cooperation with the Siskiyou National Forest in a pilot-scale test of aerial spraying in a typical brushfield to determine its cost and effectiveness in preparing a problem brush area for reforestation.

Relation of site index to elevation and soils. What sites in the mixed-conifer forests are best adapted to Douglas-fir; to sugar pine; or to ponderosa pine? An exploratory study to help provide answers for the South Umpqua drainage was started in midsummer in cooperation with the Umpqua National Forest. First efforts were directed toward determining to what extent site index for each species is related to elevation, topography, and soils.

Site index for Douglas-fir showed a strong relation to elevation and increased at higher elevations on both north and south slopes. Site index for sugar pine was greater than for Douglas-fir at lower elevations but less than for Douglas-fir at higher elevations. The breaking point appears to be somewhere between 2,800 and 3,600 feet.

Soil was also observed to exert a strong influence on site index. For one deep, red soil on a south slope, site index was 18 feet higher for Douglas-fir and 33 feet higher for sugar pine than average for that elevation. In contrast, site index on a quartz diorite soil of the Klamath Mountains formation was 41 feet shorter for Douglas-fir and 30 feet shorter for sugar pine than average for that elevation.

Leads from the 1955 study will be followed during the 1956 field season in an effort to develop preliminary guides that will be helpful in the establishment of boundaries for sugar-pine management units.

East-Side Ponderosa Pine

Initial plans for the Round Mountain Experimental Management Block moved ahead during the year as a joint project of Forest Service administration and research. Established in 1954, this 25,000-acre pilot plant on the Deschutes National Forest will be used to determine the feasibility of more intensive forest practices and to study problems of sustained yield planning and management. Developments during 1955 included:

1. Sale of 32 million board feet to salvage dead, dying, and high-risk trees in a 15-percent cut, and to establish a road system on the unit.

2. Procurement of aerial photos covering the unit at scales of both 1/20,000 and 1/10,000.

3. Preliminary study of inventory and accounting procedures for the unit made in cooperation with Professor Ray A. Yoder, School of Forestry, Oregon State College.

Rodent and deer damage to plantations. In 1954, a study was established on the Ochoco National Forest to determine the influence of seeded grass on survival and growth of planted ponderosa pine. During

1955, rodents and deer seriously damaged this newly established plantation. Through the growing season, 70 percent of the planted pines were browsed or injured by animals, many so severely that recovery is doubtful. About half of the damage was attributed to deer browsing and the remainder to rodents, principally snowshoe hares. Half of the 7 percent loss in planted seedlings was due to animal damage.

In another planting study on the Deschutes National Forest, only 15 of 135 trees examined were free of some sort of animal injury. Animals have, of course, been recognized as an important cause of loss and damage to pine plantations in central Oregon, but this experience strongly emphasizes that too little is known of factors relating to such damage and economical methods of control or prevention.

Brush control. During 1955, studies were focused on development of more precise prescriptions (chemical, carrier, and timing) for killing brush without damaging intermingled ponderosa pine.

Trends thus far indicate ponderosa pine is more tolerant of foliage sprays of 2,4-DP and 2,4,5-TP than of sprays of 2,4,5-T. In turn, it is more tolerant of 2,4,5-T than of 2,4-D. Water carriers were found to be less damaging than oil emulsion and ponderosa pine generally appeared to be most susceptible to damage at the start of and during shoot elongation and height growth.

Manzanita (Arctostaphylos parryana var. pinetorum) can apparently be killed without damage to pine with as little as one-half pound 2,4-D acid per acre in 3 gallons of oil emulsion carrier. Minimum dosage has not yet been determined.

For snowbrush (Ceanothus velutinus) 2,4,5-T appears to be superior to 2,4-D and less damaging to pine. However, none of the treatments tried so far have killed the entire plant and prevented resprouting.

All four chemicals effectively killed aerial parts of chinkapin (Castanopsis sempervirens) but plants resprout. 2,4-DP and 2,4,5-TP may be best because they are less damaging to ponderosa pine.

Bitterbrush (Purshia tridentata) was effectively killed by all four chemicals at one pound acid per acre.

Chemical thinning of ponderosa pine. Use of amine 2,4-D in ax cuts was extended to small-scale field trials on several eastern Oregon national forests. Two important problems were disclosed:

1. Too many untreated trees, adjacent to treated trees were killed, apparently through root contact.

2. Too many reserve trees died because of increased bark beetle activity in thinned areas.

Growth after partial cutting in ponderosa pine. Growth records have been maintained over a fairly long period of years for 32 study plots in eastern Oregon. An analysis of recent records shows that gross annual increment per acre ranges from 28 board feet, where only 764 board feet was reserved, to 220 board feet on a reserve of 7,196 board feet. For most study plots, gross increment ranged from 80 to 140 board feet on reserve volumes of 4,000 to 18,000 board feet per acre. In no case have released seedlings and saplings grown large enough to contribute substantially to increment through ingrowth.

Increment is not closely related to percent of cut, volume of reserve stand, or to the system of marking used (group, thrift, economic selection, diameter-limit, etc.). The factor which seems to outweigh all others is the age and vigor of trees that comprise the reserve stand.

Growth of open-grown ponderosa pines. A small-scale study was conducted to help provide standards for selecting plus trees in genetics work and also to gain a better understanding of the relationship of growth rate and wood quality to spacing. Twenty open-grown pole-size trees on site IV averaged 4.9 inches in diameter growth and 11.8 feet in height growth during the last 10 years. This is about twice the diameter growth expected of dominant trees in pole stands on site IV and suggests that growth of dominants can be increased substantially through thinning.

Forest Genetics

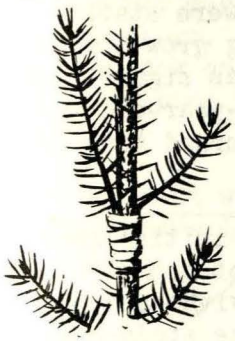
Plus trees. To stimulate interest in seeking and recognizing plus trees, a tentative guide applying to the Douglas-fir region was released during the year. A closely related action was the establishment of a plus-tree register, which will be available to all agencies, companies, and individuals who may wish to enroll candidate trees. This central register should facilitate the collection of pollen and cuttings for tree breeding and the establishment of seed orchards. The first tree registered was an outstanding 64-year-old Douglas-fir on the McCleary Experimental Forest, which is maintained by the Station in cooperation with the Simpson Logging Company.

Provenance studies continued. Older provenance studies, started in 1915 for Douglas-fir and in 1928 for ponderosa pine, received major attention during the year. New field measurements were completed for Douglas-fir and initiated for ponderosa pine. The Douglas-fir data are receiving an intensive analysis, which should be completed in 1956.

Is bud bursting under close genetic control in Douglas-fir? Relative order of bud bursting does not change if various stocks of Douglas-fir are moved over a considerable range in distance and altitude. This was first suggested in 1933 and 1934 from observations in the Douglas-fir heredity plantations at Wind River and Mt. Hood. Strains of Douglas-fir which burst their buds earliest at Wind River were the ones that burst earliest at Mt. Hood.

In 1955, observations were repeated on the 3 separate plantations containing 40-year-old progeny from the 13 seed sources. As in earlier observations, the same order of bud bursting that occurred at 1,100 feet elevation at Wind River also prevailed later at both 2,600 feet and 4,600 feet elevation at Mt. Hood. Apparently altitude and latitude do not change inherent earliness or lateness with which Douglas-fir bursts its buds.

This relationship is also being tested in a more closely controlled study on the McDonald Forest at Corvallis, where a clone of 12 trees from the same parent was rooted by W. F. McCulloch in 1939. Now 8 to 26 feet tall, these trees were used as understock of identical genetic makeup for grafting. On each tree, scion material was grafted from 7 trees of known bud-bursting dates. Some were known to burst their buds early; others, late. Thus early and late scion materials were grafted on trees of identical genetic characteristics in a replicated experiment. Differences in bud bursting and other characteristics that show in the scions will give a good measure of the extent of hereditary control over these characteristics. Grafting was completed in 1955.



Can cultural measures increase Douglas-fir cone production? Jointly with the Region Six Division of Timber Management, a study was started to learn if cone production in a seed-collection area of young Douglas-fir can be increased by thinning or by thinning and topping. This study is in a 40-year-old Douglas-fir stand on Larch Mountain, recently designated as a natural seed collection area. Some plots will be thinned to provide practically free growth. On others, in addition to thinning, all trees will be topped to a 32-foot height. Cone production resulting from the two treatments will be compared with production in an undisturbed stand.

Forest Soils

Prescribed burning and physical soil properties. A case study on the use of prescribed burn for thinning overcrowded stands of ponderosa pine poles and saplings was started in 1952 on the Colville Indian Reservation in cooperation with the Bureau of Indian Affairs.

One of the several major questions to be answered was: "What is the effect of prescribed burning on physical soil conditions?" Results of the soils phase, which is now completed, indicate that both percolation rate and large pore volume were increased after burning. In this case, prescribed burning is believed to have exerted a beneficial effect on the soil by increasing soil-water percolation and reducing the possibility of soil erosion from surface runoff.

Growth of Douglas-fir seedlings after slash burning. An understanding of the ways slash burning may affect seedling growth is important in evaluating present slash-disposal practices. One study, aimed at determining effects of slash burning on seedling growth, was carried out at both the H. J. Andrews and Wind River Experimental Forests.

Natural Douglas-fir seedlings growing on unburned, lightly burned, and severely burned soils were dug and their height and root length measured. More than 400 seedlings, including both 1- and 2-year-old trees, were measured.

On the H. J. Andrews Experimental Forest, seedlings differed little in average height and root length; none of the differences were statistically significant. At Wind River, differences in seedling growth were more pronounced. For 1-year-old seedlings, height growth was significantly greater on severely burned than on unburned soil. For 2-year-old seedlings, height growth was significantly greater on lightly burned than on unburned soil.

These findings strongly indicate that for both areas initial growth of young Douglas-fir seedlings under field conditions was not inhibited by slash burning. Effects of slash burning on seedling survival and growth after the first two years are the subject of a more intensive study currently under way.

Does brush eradication influence soil moisture and surface temperature? Since brush control is only the initial step in reforesting brushfields, this question was believed to merit early attention. Accordingly, measurements were taken during the 1955 growing season in a brushfield on the Deschutes National Forest where manzanita and ceanothus on several sample plots had previously been killed through aerial spraying. Three conditions were studied: Green brush cover, dead brush cover (after herbicidal treatment), and bare ground (brush killed with herbicides and subsequently uprooted and removed from the plot).

Results indicate that an excellent soil moisture situation is created when the brush cover is killed. Despite an abnormally dry year, soil moisture at 1- and 2-foot depths for both dead brush and bare ground conditions remained at about 20 percent by weight by the end of October. This was a loss of only 5 percent from the initial moisture content at the start of the growing season. In contrast, soil moisture was reduced steadily on

the areas of green brush, reaching a level near the permanent wilting point by the first week in July.

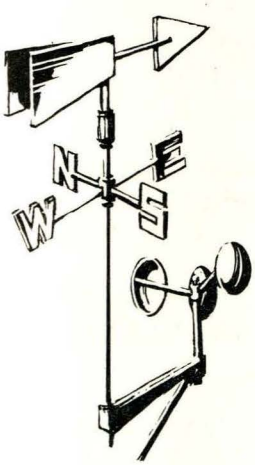
Surface soil temperatures were in most cases not as great where brush was killed or killed and cleared as in the undisturbed brushfield where the dark-colored litter beneath the green brush frequently reached temperatures in excess of 163° F.

Apparently, the deadening of brush can be expected to favor regeneration by a substantial improvement in soil moisture and a slight improvement in surface soil temperature.

Fire Studies

More effective research in fire and weather relations through cooperation with other public agencies became possible during the year when the U. S. Weather Bureau assigned a research forecaster to Portland and the Oregon State Board of Forestry hired a research meteorologist. To assist cooperative effort in this field, the Station fire research staff has participated in several meetings with these other fire-weather researchers. The most pressing fire-weather problems have been defined and attack on those of highest priority has been planned. Investigation of wind in mountainous terrain will receive first attention by the group.

East winds west of the Cascades. Foresters in Oregon and Washington have long recognized these winds as the most dangerous fire weather element. Severe, dry east winds often blow continuously for 36-48 hours with speeds of 15 to 35 m.p.h. During such periods, humidities range from 15 to 30 percent with little if any increase during the night hours.



Frequency with which these winds may be expected during different parts of the fire season is important in fire-control planning. Using Weather Bureau records of ground-level and pilot-balloon observations at Portland, frequencies of dry east wind over northwest Oregon and southwest Washington over a 15-year period were determined. These disclosed that although east winds occur most frequently during cooler months, they may occur in any month. Severe east winds occur most frequently in January, but September, October, and November are also months of high frequency. Severe east winds are least likely in June, July, and August.

Fire weather severity varies. 1955 fire weather severity west of the Cascades was found to have averaged below normal for the third successive season. Locally, however, conditions ranged all the way from severe fire weather in southwest Oregon to one of the coolest and

dampest seasons of record in western Washington. These ratings, covering the April-through-October fire season, are based on: Average time since a wetting rain, total number of rainless days, and burning index. Lightning storm frequency was also below normal throughout the region.

Severe fire weather was concentrated in the period August 1 to September 12 when drought prevailed. It culminated in a week of high temperatures, including two days with dry lightning storms.

Plans for Forest Management Research in 1956

One noteworthy addition to the research program in 1956 will be the initiation of a project on the management of lodgepole pine forests in the Blue Mountain area under the leadership of the Blue Mountain Research Center. This will be a multiple-use project in the sense that research in range, watershed, and forest management will be coordinated into one series of studies. Financing of the forest management phases is made possible through cooperation of the Pilot Rock Lumber Company at Pilot Rock, Oreg.

Other tasks that will receive special emphasis in 1956 include:

1. Preparation and review of a Departmental publication on "Commercial Thinning in Young Douglas-fir."

2. Publication of "Yield Tables for Western Hemlock" as a technical bulletin in cooperation with Dr. George H. Barnes, School of Forestry, Oregon State College.

3. Publication of "Management and Utilization of Red Alder" as a Departmental release in collaboration with the Station's Forest Utilization Service.

4. Preparation of drafts covering principal Northwest tree species for servicewide publication, "Silvical Characteristics of Important Forest Trees of the United States."

5. Preparation and release of a technical article, "Use of Gross Yield Tables for Douglas-fir to Establish Thinning Schedules and Control Growing Stock."

6. Initiation for east-side ponderosa pine of a new spacing-increment study.

PUBLICATIONS and ARTICLES

1955

By members of the staff and cooperators

DEPARTMENTAL PUBLICATIONS

Johnson, F. A., comp. Volume tables for Pacific Northwest trees. U. S. Dept. Agr. Agriculture Handbook 92, 122 tables. September.

Groups all important Pacific Northwest volume tables in one publication for easy reference.

Rummell, R. S., and Holscher, C. E. Seeding summer ranges in eastern Oregon and Washington. U. S. Dept. Agr. Farmers' Bul. 2091, 34 pp., illus. October.

Includes guides for reseeding in sagebrush, grassland, and meadow types; and logging-disturbed and burned areas in forested zones. Specific directions are given for what areas to seed, what species to seed, and when and how to seed.

Wright, K. H., joint author with Evenden, J. C. Douglas-fir beetle. U. S. Dept. Agr. Forest Pest Leaflet 5, 4 pp., illus. July.

A presentation of basic information on biology, ecology, and control of this forest pest.

STATION PUBLICATIONS
(Processed)

Forest Survey Reports

Statistical reports, by counties, presenting results of recent reinventories of Oregon and Washington forests. Contain information about forest land area and ownership, and timber volumes and utilization. Some descriptive and interpretative information is included also.

119 Forest statistics for Wheeler Co., Oreg. By F. L. Moravets. 23 pp., illus. March.

120 Forest statistics for Morrow Co., Oreg. By D. R. Gedney and W. H. Ray. 25 pp., illus. June.

Forest Survey Reports (con.)

121 Forest statistics for Yakima Co., Wash. By Benjamin Spada and J. H. Usher. 29 pp., illus. August.

122 Forest statistics for Columbia Co., Oreg. By F. L. Moravets. 28 pp., illus. October.

123 Forest statistics for Thurston Co., Wash. By M. P. Twerdal and Don Minore. 27 pp., illus. October.

Research Notes

108 1954 midsummer fuel moistures in Oregon and Washington national forests compared with other years. By O. P. Cramer. 3 pp. February.

Midsummer fuel moistures were well above normal except for near normal averages in eastern and southwestern Oregon.

109 Chemical brush control on central Oregon ponderosa pine lands. By W. G. Dahms. 5 pp. February.

One pound per acre of low volatile ester 2,4-D killed manzanita outright and the aerial parts of snowbrush.

110 Increment and mortality in a virgin Douglas-fir forest. By R. W. Steele and N. P. Worthington. 6 pp., illus. April.

A 6-year record in a 350-year-old stand shows a gross annual growth of 767 board feet per acre. However, stand volume is practically static because mortality over the 6-year period about equaled gross growth. Douglas-fir is gradually being replaced by western hemlock and balsam firs.

111 A comparison of conifers planted on the Hemlock Experimental Forest. By N. P. Worthington. 5 pp. April.

Up to the fifth year, 1-0 Douglas-fir nursery stock had better survival than either 2-0 or "jumbo" stock. Other species tested included western hemlock and grand fir, which had the best and poorest survival, respectively.

112 Estimating past diameters of Douglas-fir trees. By F. A. Johnson. 3 pp. illus. April.

Of value for growth studies based on increment cores. Recognizes bark growth.

Research Notes (con.)

113 Bear damage to young Douglas-fir. By T. W. Childs and N. P. Worthington. 4 pp., illus. April.

Serious damage consists principally of killing by complete girdling. When girdling is partial, the tree usually survives and decay seldom becomes extensive.

114 Needle blight of ponderosa pine. By T. W. Childs. 6 pp., illus. April.

The disease sometimes causes rapid and direct killing. In most infected stands, however, damage consists principally of reduction in growth rate and gradual increase in mortality as some of the weakened trees are attacked by other parasites.

115 Growth of Douglas-fir seedlings after slash burning. By R. F. Tarrant and Ernest Wright. 3 pp., illus. May.

On two study areas where slash had been burned, subsequent growth of natural seedlings under field conditions was not inhibited.

116 Synopsis of present information concerning Poria weirii root rot in Douglas-fir. By T. W. Childs. 2 pp. April.

Summarizes information now available on behavior of this disease and recommends practices for reduction of damage.

117 Growth after precommercial thinning in two stands of Douglas-fir. By R. W. Steele. 6 pp., illus. May.

A 20-year record of growth after thinning in 20- to 30-year-old stands showed that thinned and unthinned stands had about equal cubic-foot volumes at the end of the period. Height, diameter, and volume growth per tree averaged greater in the thinned stand, however.

118 Preliminary recommendations for seedspotting sugar pine in southwest Oregon. By W. I. Stein. 6 pp., illus. June.

Administrative and experimental trials indicate that sugar pine in southwest Oregon can be successfully seedspotted if high-quality seed is used and the operation is carefully conducted.

Research Notes (con.)

119 Seedling distribution on a spruce-hemlock clearcut. By Carl M. Berntsen. 7 pp., illus. June.

A 20-acre opening was well stocked in 6 years. North slopes had twice as many seedlings as south slopes. Burned surfaces had more seedlings but unburned surfaces had better seedling distribution.

120 Dimension lumber grades from white fir in Lakeview area. By E. E. Matson. 2 pp. June.

Gives dry, surfaced lumber recovery and lumber selling prices for 283 white fir logs cut at the American Forest Products Corporation sawmill in Lakeview, Oreg.

121 Lumber-grade recovery from 110-year-old Douglas-fir thinnings. By N. P. Worthington. 6 pp., illus. August.

Because of loose, black knots, lumber recovery was only 52 percent No. 1 Common and Better. In a previous study, lumber recovery from four younger stands, which had more green limbs, averaged 85 percent No. 1 Common and Better.

122 Tentative guides for the selection of plus trees and superior stands in Douglas-fir. By L. A. Isaac. 9 pp., illus. October.

Selection of plus trees is an important phase of species improvement and one which will require the active participation of all foresters.

123 1955 forest fire weather in western Oregon and Washington. By O. P. Cramer. 8 pp. November.

For the season as a whole, fire weather averaged near normal for western Oregon. In southern Oregon, however, severe conditions prevailed in late August and early September. Western Washington experienced below normal fire weather severity for the third successive year.

124 Ponderosa pine lumber recovery in Lakeview, Oreg. area. By E. E. Matson. 13 pp., illus. December.

Gives dry, surfaced lumber recovery by log grades and diameter groups for 588 ponderosa pine logs cut at the American Forest Products Corporation sawmill in Lakeview, Oreg.

Research Papers

11 An analysis of production and costs in high-lead yarding. By M. E. Tennas, R. H. Ruth, and C. M. Berntsen. 37 pp., illus. February.

Elements of yarding cost were analyzed in detail through an intensive time and production study of a high-lead setting in a 100-year-old spruce-hemlock stand. Distance was found to be the most significant factor affecting cost.

12 A 4-year record of Sitka spruce and western hemlock seed fall. By R. H. Ruth and C. M. Berntsen. 13 pp., illus. March.

Areas up to 80 acres in size were adequately reseeded (and restocked) in the 4-year period by 2 heavy and 1 medium seed crop from a 100-year-old stand.

13 Brush control on forest lands, with emphasis on promising methods for the Pacific Northwest (a review of selected references). By W. G. Dahms and G. A. James. 81 pp. May.

Mechanical, biological, chemical, and burning control methods are discussed and compared. Results from trials of chemical control of 60 Pacific Northwest tree, shrub, and weed species are summarized in table form.

14 Gross yield and mortality tables for fully stocked stands of Douglas-fir. By G. R. Staebler. 20 pp., illus. September.

Mortality figures provide a means for conservatively estimating the volumes that can be removed through periodic thinning. Gross yield figures enable estimation of maximum yields possible under intensive management. The tables cover sites I through V and rotation from 20 to 160 years.

15 Economic considerations in Douglas-fir stand establishment. By T. A. McClay. 10 pp., illus. September.

Offers a procedure by which a forest manager can determine the most economical course to follow, when confronted with several alternatives, in establishing a stand of Douglas-fir.

Miscellaneous

Buckhorn, W. J. Forest insect surveys, Ochoco National Forest and adjacent timberlands. 12 pp., illus. April.

Results of two types of cooperative forest insect surveys on the Ochoco National Forest and adjacent timberlands. The surveys cover the 10-year period from 1945 through 1954.

Driscoll, R. S. A guide to the Starkey Experimental Forest and Range. 21 pp., illus.

Handbook for visitors. Describes the research program and summarizes the history of use, physical and climatic conditions, vegetation, problems, management of ponderosa pine ranges, and results of grazing investigations.

Isaac, L. A. A proposed plus-tree register for the Pacific Northwest. 12 pp., illus. November.

A suggested plan for a centralized register of plus trees (finest specimens in natural stands) of the Pacific Northwest. Includes a proposed registration form.

Skinner, E. C. Log position volume tables for western conifers. 54 pp. March.

Useful for estimating standing timber volumes by log grades.

Station Staff. Pacific Northwest Forest and Range Expt. Sta. Annual Report--1954. 68 pp. March.

Summary of Station research accomplishments during calendar year 1954 and plans for 1955.

Wear, J. F., and Buckhorn, W. J. Organization and conduct of forest insect aerial surveys in Oregon and Washington. 41 pp., illus. March.

Detailed account of aerial survey equipment and personnel requirements, considerations in scheduling surveys, survey techniques, and survey costs.

Whiteside, J. M. Plan for the technical direction of the 1955 Oregon spruce budworm control project. 16 pp., illus. April.

Outline of responsibilities for technical supervision and conduct of biological phases of work prior to spraying. Also, guidelines for timing the release of spray blocks and determining the degree of control obtained.

Miscellaneous (con.)

Whiteside, J. M. Important forest insect outbreaks in Oregon and Washington. 4 pp. November.

A summary of the principal forest insect infestations in 1955.

_____ Report of forest insect surveys in Oregon and Washington, season of 1955. 55 pp., illus. October.

A detailed report of the extent and severity of various forest insect infestations, as detected by all cooperating agencies, with recommendations for control.

_____ and Gruba, A. G. Report on the emergence of overwintering spruce budworm larvae on units proposed for spraying during the 1955 Oregon spruce budworm control project. 5 pp. April.

Estimates of potential feeding populations of spruce budworm were obtained by two methods of handling overwintered material.

ARTICLES AND COOPERATIVE PUBLICATIONS

Baudendistel, M. E. Industry expansion is rapid. Western Conservation Jour. 12 (4): 8-10, illus. July-August.

Observations and data on the expanding pulp and paper industry in the Pacific Northwest. Includes plant capacity by pulping process, raw material requirements, species used, and related information.

Berntsen, C. M. How to thin on steep ground. Lumberman 82 (5): 76, illus. April.

Using a gas shovel mounted on a halftrack, logs 18 feet long were successfully yarded from steep ground on a strip reaching 300 feet below a rock-surfaced road. The thinning operation was in a 100-year-old spruce-hemlock stand. Neither ground disturbance nor damage to reserve trees was excessive.

Costello, D. F. Review of "The Pacific Northwest." Ed. 2. Edited by Otis W. Freeman and Howard H. Martin. 1954. Jour. Range Mangt. 8 (2): 86-87. March.

Emphasizes that the book treats the Pacific Northwest as a distinct region unified by the Columbia River system. Includes general information on almost every resource and natural phenomenon in the Northwest.

_____ The need for research on ranges used by big game. Proceedings of the Western Assoc. of State Game and Fish Commissioners. 34: 177-181. May.

A developmental and historical summary of accomplishments in big-game habitat research. Outlines various research stages, such as description, measurement, methodology, concept development, testing, and application.

_____, Hickie, Paul, and Hill, R. R. The integration of professional forestry, range management and wildlife management responsibilities. Jour. Forestry 53 (1): 58-62. January.

An exploration of the problems, responsibilities, and economic and social values associated with the professional handling of wild lands. Integrated forest, range, and wildlife research must provide the basis for better management, but mutual understanding of objectives is necessary.

Cowlin, R. W. Pulp mills are thirsty. Western Conservation Jour. 12 (4): 16-17, 21, illus. July-August.

Points out that continued expansion of the pulp industry in the Pacific Northwest is dependent upon abundant supplies of clean water. Shows importance of the forested watersheds in that regard and outlines a watershed management research program.

_____ Young-growth Douglas fir holds the key. Lumberman 82 (5): 58, 74, illus. April.

Introduces a series of technical articles by Station authors on the subject of second-growth Douglas-fir management. Briefly describes the importance of second growth to the economy of the Douglas-fir subregion.

Driscoll, R. S. Grazing season determined by forage maturity. Oregon Cattleman 4 (2): 6, 13-15, illus. July.

Summarizes preliminary information on effects of precipitation and temperature on herbage production and development of elk sedge on the Starkey Experimental Forest and Range.

Dunford, E. G., and Weitzman, Sidney. Managing forests to control soil erosion. U. S. Dept. Agr. Yearbook 1955: 235-242, illus.

A discussion of factors causing erosion on forest and rangelands, and suggestions for controlling soil disturbance resulting from road building, logging, grazing, and fire.

Eversole, K. R. Spacing tests in a Douglas-fir plantation. Forest Science 1 (1): 14-18, illus. March.

Continuing records from a 27-year-old plantation indicate that density affects height as well as diameter growth of dominant trees. As spacing increases from 4 x 4 to 12 x 12 feet, growth also increases.

Hayes, G. L., and Buell, J. H. Trees also need water at the right time and place. U. S. Dept. Agr. Yearbook 1955: 219-228, illus.

The relation of available moisture to the distribution of forest growth on the earth's surface is discussed in broad terms.

Johnson, F. A. Predicting future stand volumes for young well-stocked Douglas-fir forests: a comparison of methods. Jour. Forestry 53 (4): 253-255, illus. April.

Seven prediction methods were tested, using data from permanent sample plots.

Knauss, A. C. Seasoning defects of western softwoods. Western Dry Kiln Clubs 7th annual meeting: 10-18. April.

Itemizes and describes defects that develop in western softwoods when poorly seasoned. Good seasoning practices will minimize development of these defects.

Morris, W. G. Accidental fires in slash in western Oregon and Washington. U. S. Forest Serv. Fire Control Notes 16 (2): 21-23. April.

Analysis of 53 accidental slash fires during 1950-53 on national forest land. Provides data on number of fires by causes with accompanying statistics on fire behavior, attack, and area burned.

Shaw, E. W. Christmas tree farms. Oregon Farmer 78 (1): 12-13. Also, Washington Farmer 80 (1): 12-13. January 6.

Forest land below average in site quality can be used to advantage for Douglas-fir Christmas tree production because slow growth fosters good Christmas tree form.

Shaw, E. W. Tree's biography is written. Western Conservation Jour. 12 (4): 2 pp. (insert), illus. July-August.

The life history of a 62-year-old Douglas-fir tree in the Hemlock Experimental Forest is reconstructed. This tree was the first to qualify for the Station's plus tree register.

Silen, R. R. More efficient road patterns for a Douglas-fir drainage. Timberman 56 (6): 82, 85-88, illus. April.

Pilot-plant trials at the H. J. Andrews Experimental Forest show that systematic road planning can almost double the percentage of an area within the optimum yarding distance and reduce road mileage per unit of forest area.

Staebler, G. R. Extending the Douglas-fir yield tables to include mortality. Proceedings of the Soc. of Amer. Foresters 1954: 54-59, illus.

Records from permanent growth plots are used to estimate mortality and gross yields in fully stocked stands of Douglas-fir.

_____ Planted hemlock shows good survival. Pulp and Paper 29 (1): 106. January.

A check of two hemlock plantations on sites with heavy ground cover showed a survival of 90 percent at the end of a year.

_____ Thinning trials have requiem. Lumberman 82 (5): 69-70, illus. April.

Thinning plots in young Douglas-fir, measured after the trees were killed by fire, showed that trees in the thinned stand made better growth than those in the unthinned stand. Also, growth was on larger, cleaner boles.

Steele, R. W. Thinning nine-year-old Douglas-fir by spacing and dominance methods. Northwest Science 29 (2): 84-89, illus. May.

Significantly better growth was obtained by reserving dominant trees than by optimum spacing without regard to dominance. Stands thinned by either method had better growth than unthinned stands.

Stein, W. I. Pruning to different heights in young Douglas-fir. Jour. Forestry 53 (5): 352-355, illus. May.

Removal of a fourth of the live crown of 28-year-old Douglas-fir trees resulted in a slight increase in both height and diameter growth. Removal of half of the live crown made a significant reduction in growth, and removal of three-fourths of the live crown nearly halved growth.

Stein, W. I. Some lessons in artificial regeneration from southwestern Oregon. Northwest Science 29 (1): 10-22, illus. February.

Seed spotting with rodent control offers promise with sugar pine in southwestern Oregon. Seedling enemies--rodents, cutworms, and competing vegetation--are at lowest ebb immediately after cutting.

Tarrant, R. F., joint author with Starr, W. A., and others. Evaluating and mapping mountain land features for forest management purposes. Washington State Agr. Expt. Sta. Cir. 271, 22 pp., illus. June. (Processed.)

Presents a procedure for appraising and mapping conditions of geology, soil, and topography that bear on the management of national forest lands in the State of Washington.

Wear, J. F., and Dilworth, J. R. Color photos aid salvage of beetle-killed Douglas-fir timber as mapping technique is developed. Lumberman 82 (13): 88-89, 132-133, illus. December.

A report on the advantages of color transparencies in estimating beetle-kill from the air, and various techniques employed.

Worthington, N. P. Mortality can be salvaged. Lumberman 82 (5): 59-60, illus. April.

Mortality in young Douglas-fir stands often equals half the growth. At the Hemlock Experimental Forest, dead and dying trees were salvaged at a profit and the operation helped defray road costs.

_____ Should you reclassify your timberlands? Timberman 56 (9): 70, 72, 74. July.

For stands where final harvest will be postponed for 20 years or more, classification under the Washington State reforestation law usually affords financial advantages to the owner.

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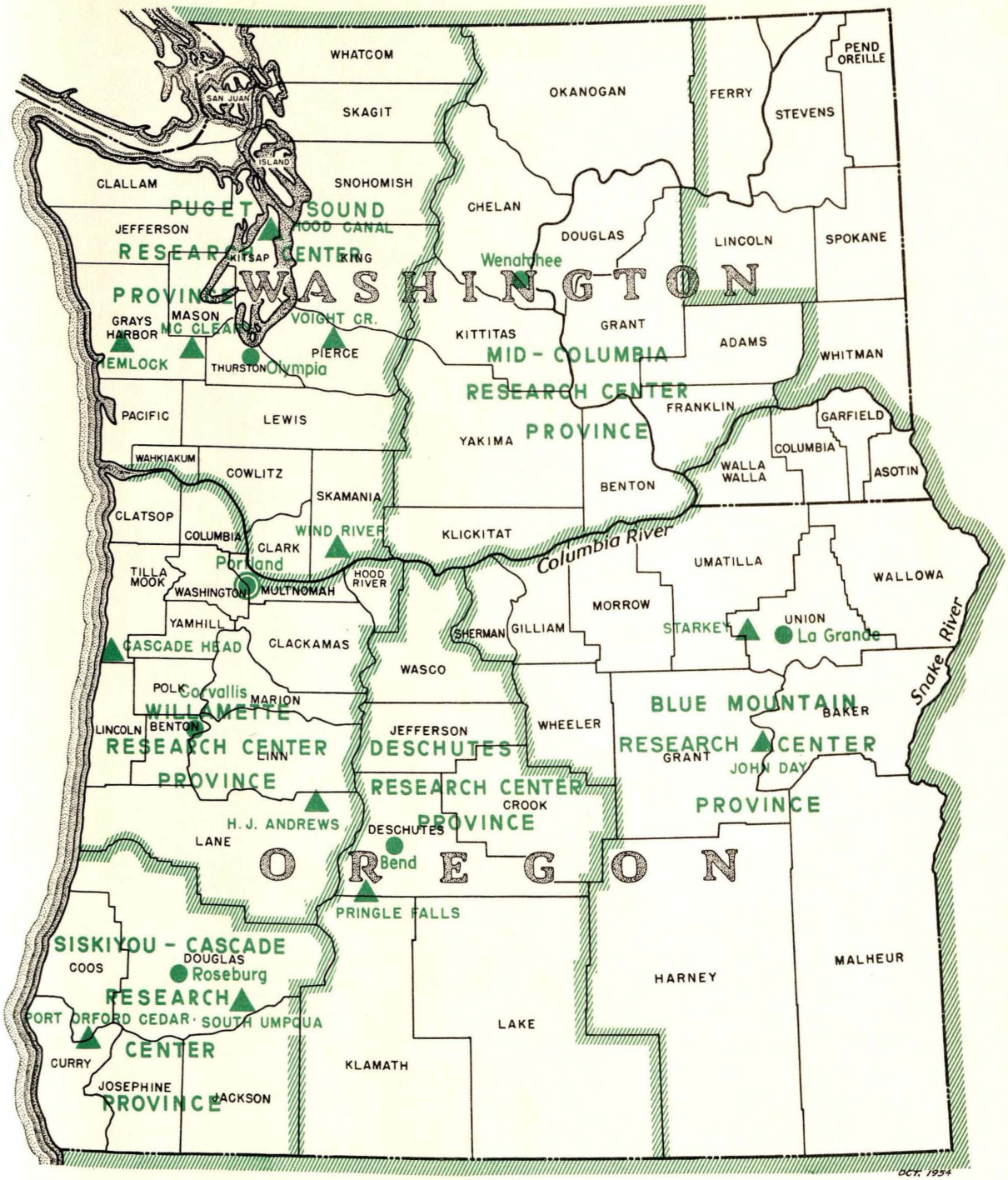

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